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Allium commutatum Guss. - El Kala, Algeria

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***Allium commutatum* Guss. and the « small islands specialist » plants species of the Western Mediterranean.** The Mediterranean is a very large sea famous for its numerous small islands. Even if the western basin is mostly known for its big and beautiful islands, it contains more than 1000 small islands, often less than 1000 ha wide. Current enthusiasm in exploring very small islands (sometimes rocks no more than one hectare) is particularly supported by the "PIM initiative" of French "Conservatoire du Littoral". By boat, swimming or sometimes by feet, most of them were scientifically explored for the first time and a lot are still to be explored. One of the major surprises was the recurrent discovery of some plant species considered extremely rare or not yet known on the continent. *Allium commutatum* Guss., a steno-Mediterranean rare Amaryllidaceae, was recently discovered as new for Tunisia and Algeria thanks to its presence on very small islands, and recent explorations led to confirm its presence also on the continent (Africa), on inaccessible rocks with few vegetation cover. In SW-Sardinia, out of the six known localities, five are on peripheric small islands and one on a Cape of the main island. Around Corsica, more than twenty islets are concerned. In Corsica and mainland France, the species is rarely pure and most often hybridised with *A. polyanthum* Schult. & Schult. f., a common ruderal plant. Even within the small islands archipelago of La Galite or Zembra in Tunisia, *A. commutatum* is located on the smallest islets, while *A. polyanthum* is growing on the main island. Among its special properties, *A. commutatum* is known to have some bulblets resistant to seawater. *Nananthea perpusilla* (Loisel.) DC., an extremely rare Corso-Sardinian endemism and monotypic genus of Asteraceae, is the most famous and best studied small islands specialist plant species. *Stachys brachyclada* De Noé, a western Mediterranean rare Lamiaceae, is distributed from France (three islets near Marseille) until Chafarinas archipelago (opposite to Moroccan coast) and is very limited on the mainland. *Fumaria munbyi* Boiss. & Reut., a south-western Mediterranean rare Papaveracecae, was indicated in the past on the continental littoral but is currently known mainly on Habibas archipelago (Algeria) and Columbretes archipelago (Spain). *Hymenolobus procumbens* subsp. *revelieri* (Jord.) Greuter & Burdet, a western Mediterranean rare Brassicaceae, may be a good candidate but, because of taxonomical difficulties, its exact distribution is still not known. Of course, a lot of narrow endemic species restricted on one or a few islands are *de facto* small islands specialist, but for the species with relatively large distribution, this phenomenon is still poorly known and understudied. Avoiding concurrence of species from mainland is probably a major cause, not only competition from species with the same ecological niche but also genetic aggressiveness of parent species. Furthermore, Humans artificialise the mainland littoral more easily than inaccessible islets. Dispersal capaeities of small islands speeialist should be explored in light of those species preferring the mainland. Genetic pattern and historical relations between populations from such remote small islands are misunderstood and represent a challenge.

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Plant trees species for restoration program in Ranupani, Bromo Tengger Semeru National Park Indonesia

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ABSTRACT Restoration programs in conservation areas need a basis data regarding plant species diversity which is indigenous for the restoration area target. The availability of such data is useful for selecting appropriate plant species for reintroduction programs as a crucial part in restoration programs. The aim of this paper is to identify potential plant trees species for a restoration program in tropical highland ecosystem. There are potential plant trees species for Ranupani area, including *Acer laurinum*, *Acmena acuminatissima*, *Casuarina junghuhniana*, *Dacrycarpus imbricatus*, *Engelhardtia spicata*, *Myrsine korthalsii*, *Lithocarpus sundaicus*, *Lithocarpus korthalsii*, *Macropanax dispermum*, *Trema orientalis*, *Turpinia sphaerocarpa*, *Omalanthus giganteus*, and *Astronia spectabilis*. Some of them, i.e. *Engelhardtia spicata*, *Omalanthus giganteus*, *Astronia spectabilis*, *Trema orientalis* and *Casuarina junghuhniana* play an important role as pioneer species. In the first step of restoration program implementation, these species can be planted with some pioneer native shrubs and herbs to initiate and accelerate the succession process in the restoration areas.

KEY WORDS Mountain biodiversity; degradation; restoration; native species; lakes ecosystem; succession.

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INTRODUCTION

Recently, problems related to the habitat degradation in national parks became one of the crucial issues in the world. As a mega biodiversity country, the role of national parks in Indonesia was considered important. While the objective of national parks has been addressed to conserve biodiversity, threats to the Indonesian national parks increase significantly (MoE, 2005).

Habitat degradation in Indonesian national parks has been reported by many authors. Several significant causes of degradation, however, come from the anthropogenic factor. Scholars point out that forest fire, illegal logging, mining and unsustainable uses of resources inside the national parks have been the causes of rapid degradation of many habitats (Salim, 2002; Miyakawa, 2010; Hakim et al., 2012).

Attempts to recover habitats that have been degraded became the focus of restoration projects. In Europe and America, restoration has been developed and implemented since past decades as an integral part of biodiversity conservation strategy (Phillips, 1996; Lowry, 2009). In Indonesia, however, restoration could be considered as a new concept and, therefore, it becomes crucial agendas in biodiversity management (Miyakawa, 2010). It is particularly crucial in Indonesian protected areas such as its national parks. Previously, in order to improve degraded areas, there were national programs called National Movement of Land Reha-

bilitation, which were intensively carried out in degraded water catchment areas, but not in protected areas system. There are many guidelines for degraded land recovery beyond protected areas, but are not available for protected areas. Absence of guidelines will lead to poor understanding of the basic philosophy and techniques for restoration. Since the objectives of management of watershed areas and national parks are different, as well as the biodiversity content, the recovery of disturbed habitats in these areas will differ both in philosophy and implementation.

Scholars stressed that the basic principle of restoration is creating original ecosystem before the area degrades (Aronson et al., 2007). In such a case, reintroduction of native plants into the degraded area is one of the main activities in restoration project (Falk et al., 1996). Efforts to recognize and identify native species become crucial in restoration programs. Plant trees species are one of the crucial components in tropical forest structure and function. Plant trees provide significant habitat for fauna and epiphytes flora, provide food and shelter for wildlife and are beneficial to water cycle in forest ecosystems. In other perspectives, trees are the ultimate resources for people surrounding forest and, for a long time, trees have been targets for exploitation (Salim, 2002; Miyakawa, 2010). Reintroduction of trees species has become the focus of many restoration projects in the world, reflecting its significance in ecosystem recovery efforts (Falk et al., 1996).

The development of restoration activities using particular demo plot is rarely done in Indonesia. One of the efforts, however, was promoted by JICA through the project entitled Project on Capacity Building for Restoration of Ecosystems in Conservation Areas. The objective of the project is to support the highland biodiversity conservation through the recovery of degraded ecosystem (restoration). In this paper, we describe the restoration planning and management of a degraded forest area surrounding two lakes in highland ecosystem. In particular, we report the first step in restoration programs in line with the attempt to provide basic data for native trees species of the study area. It is particularly important in developing countries due to the fact that people in such countries lack of experience regarding protected areas restoration programs.

MATERIALS AND METHODS

This study was set up in Ranupani area at Bromo Tengger Semeru National Park (50,276.2 hectares), East Java, Indonesia. The national park is characterized by highland ecosystem with two active volcanoes, Mt. Bromo (2,329 m) and Mt. Semeru (3,666 m). The park is famous with its huge sand sea caldera (called Tengger Caldera) and several mountain fresh water lakes in the southern slope of Mt. Semeru.

The vegetation of the park is composed of lowland to upper mountain forest types. In the lower mountain forest (about 1,200 to 1,800 m asl.) the forest species encompass *Ficus* spp., *Erythrina* sp., and *Artocarpus* spp. Understorey plants include *Brugmansia* sp., *Costus speciosus* (J. Koenig) Sm. (Costaceae), *Datura metel* L. (Solanaceae), *Musa* spp., *Colocasia* sp., *Alocasia* sp., *Pandanus* sp., palm and bamboo. The best ecosystem of lower mountain forest is located at the southern part of the park which is known as the richest habitat for orchid species. In the upper mountain forest (from 1,800 to 3,000 m asl.), the dominant tree species include *Casuarina junghuhniana* Miq (Casuarinaceae) and *Acacia decurrens* Willd. (Fabaceae). Shrubs and herbs encompass *Vaccinium* sp., *Myrica javanica* Blume (Myricaceae), *Myrsine* sp., *Lantana camara* L. (Verbenaceae), *Pimpinella* sp., *Veronica* sp., *Widelia* sp., *Dahlia* sp., *Anaphalis longifolia* (Bl.) DC (Asteraceae), *A. viscid*a (Bl.) DC (Asteraceae) and numerous grasses. The sub alpine forest (above 3,000 m asl.) is dominated by shrubs and grasses, including *Anaphalis longifolia*, *A.viscida*, *Imperata cylindrica* (L.) P.Beauv. (Poaceae) and other dwarf shrubs (Hakim, 2011).

Ranupani area consists of several ecosystems, namely Pani Lake (locally called Ranu Pani), Regulo Lake (Ranu Regulo), Ranupani Village and tropical mountainous forest (Fig. 1). Geographically, this area is located at 2,000 to 2,200 m asl, in the southern slope of Mt. Semeru. In this area, the two lakes ecosystem and its surrounding areas became the targets for restoration project by Japan International Cooperation Agency (JICA) through the project entitled Capacity Building for Restoration of Ecosystems in Conservation Areas. Recently, Pani Lake (8 ha.) has been degraded which led it to its extinction due to rapid sedimentation, eutrophication and exotic plants invasion. The Regulo Lake

(4 ha.) is relatively less disturbed, but abandoned lands in an area surrounding lake are potential threats to lake ecosystem in the near future. Illegal logging, forest clearing and forest fire in the past seem to be the responsible factors leading to forest disturbance near lakes. Nowadays, many exotic shrubs species are identified to grow strives in such areas (van Steenis, 1972; Hakim, 2011).

Field survey was carried out in mountainous forest at southern slopes of Mt. Semeru and two villages at Tengger highland, namely, Ngadas and Ranupani Villages. Related information regarding the study sites was collected and analyzed comprehensively. There were encompassed the First-year Ranupani Restoration Project Report (Hakim et al., 2011), some official documents of the national park, and the demography report of Lumajang Regency. The plant trees species diversity of the Ranupani forest area was identified through floristic surveys from July to September 2011. Prior to the field survey, several textbooks of Malesian plants diversity and phytogeography were examined, including the main literature of Javan flora, such as The Mountain Flora of Java by van Steenis (1972), Flora of Java by Backer & van den Brink (1965), and Flora Malesiana series (van Steenis, 1972). In this study, the primary focus was woody plant trees species. In the floristic survey, firstly, four hectare observation plots in two locations were set up as the sites for plants inventory. Such plots were set up in relatively undisturbed mountainous tropical forest in southern slopes of Mt. Semeru at 1,500 -2,500 m asl. In every observation plot, kinds of tree species were identified based on the morphological characteristics. Experts from Purwodadi Botanical Garden (East Java) and local people were invited during the identification process, particularly with regard to the species' scientific names and the verification of

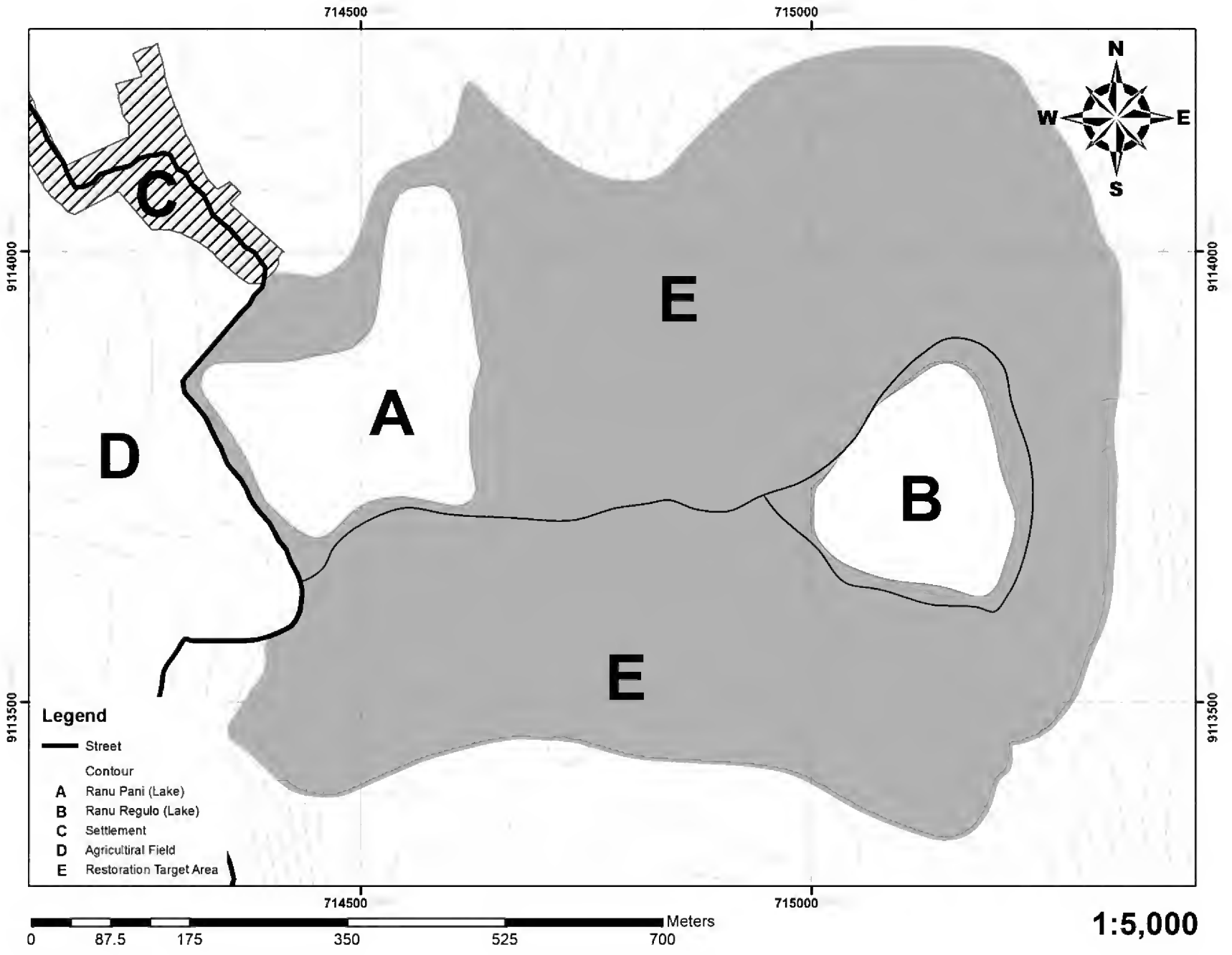

Figure 1. Restoration target area. A. Pani Lake (Ranu Pani), B. Regulo Lake (Ranu Regulo), C-D, Local settlement and intensive agriculture field in steppes land, E. Restoration target area.

their local name. Some parts of the plants were collected as herbarium samples for a detailed study in Purwodadi Botanical Garden and Plant Taxonomy Laboratory, University of Brawijaya in Malang, East Java. In the field, some important features of the tree species were recorded and documented using a digital camera. Interviews with the local people were conducted in order to get the species' economic value and characters. Ten local people which were identified as frequently entering to the forest and able to provide information were selected as informants. During the interviews, the experts from Purwodadi Botanical Garden gave some advice that the authors needed to collect information through interactive interviews. Then the data and information were analyzed descriptively.

RESULTS AND DISCUSSION

The profile of restoration target areas

Two lakes and their surrounding area have been heavily threatened due to anthropogenic factors. According to the informants, the area surrounding Pani Lake in the past was the centre of human activities. In 1908, Pani-Regulo and Kumbulo Lakes were declared as a protected area by Dutch colonial government. In the beginning of 1920, a Dutchman family had a concession to rent land surrounding Pani Lake. The family introduced European vegetables and employed local people from Probolinggo and Malang. After Indonesia held its independence in 1945 and many Westerns went out from Indonesia, the area surrounding Pani Lake was occupied by local people. In 1960, Ranupani Village was opened with ten Tenggerese families from Argosari Village as a pioneer group to open new Tenggerese settlement in Tengger highland. During 1970-1990, the population in Ranupani increased significantly. There was also a fast-growing, intensive agriculture in Ranupani Village. The growth of settlement and agriculture in Ranupani Village has given negative impacts to the lakes and forest area. Valuable woods were extracted to provide raw materials for traditional buildings and infrastructure of the village. There were also increases in fuel wood consumption. All informants argue that *Casuarina junghuhniana* and *Acacia decurrens* became the target of exploitation to provide fuel wood.

Barren lands in Ranupani area have been invaded by numerous exotic plants species. The abundance of many exotic species in open canopy is an ecological consequence of the ecosystem degradation. Recently, among the important exotic species is *Eupatorium odoratum* L. (Asteraceae). This species is considered native to South America and spread everywhere. The ability of such species to produce seeds and grow fast supports its invasion in barren lands. In Ranupani, however, local people collect old bark as fuel wood for daily purposes.

The loss of vegetation surrounding lakes has decreased the riparian structure and its function to protect the lakes. Recently, such a structure is insufficient to overcome sedimentation and pollution problems in the aquatic ecosystems. According to the respondents, in the past *Casuarina junghuhniana* and *Acacia decurrens* were abundant, but later slightly decreased due to the fact that the people cut and collected the trees as fuel wood. The water quality of Pani and Regulo Lakes has been affected heavily by pollution leading to eutrophication. This situation occurs due to the addition of exogenous substances, such as nitrates and phosphates, through fertilizers or sewage to the aquatic system. According to the respondents, most farmers in Ranupani Villages use pesticide intensively in order to improve crops and vegetables production.

Trees Species for Restoration Programs

Trees are the main component of tropical forest and their functions in hydrological and mechanical protection for lakes are considered significant. In the restoration of degraded ecosystems, trees are the plants categories which receive special attention. Identifying plant trees species is one of the crucial steps in any restoration program. Lack of such information will prevent the success of the restoration. The benefits of such information are numerous, one of which is providing the basic information regarding the native trees species and their status in the vegetation succession process. Through the field survey, several tree species notable for the restoration purposes are given below.

Acer laurinum Hassk.

Aceraceae. Local people call this species Putih Dada. This species is native to Assam (India),

Nepal, Myanmar, Cambodia, Indonesia, Laos, Malaysia, the Philippines, and Thailand. Phytogeographically, there are about 200 *Acer* species on earth with the northern hemisphere as the hot spot area of Aceraceae. *Acer laurinum* is one of the members of Aceraceae which is found in Malesian Region. In Bromo Tengger Semeru forest area, this species is easily known due to the color of its whitish leaves. *Acer laurinum* grows scattered in mountain forest from Ngadas to Ireng-Ireng forest at 800-2,250 m asl. An individual tree can reach 20-30 m in height. The quality of the wood is not very high (Sosef et al., 1998), but local people in Tengger highland use *Acer* wood for limited civil construction.

Acmena acuminatissima (Bl.) Merr et Perry

Myrtaceae. Geographically, this species is distributed in the Malesian Region and Solomon Island. It is also found in Myanmar, Thailand and southern China as native species (Sosef et al., 1998). Local people call this species Jambon/Tinggan. According to Backer & van den Brink (1965), this species grows at 25 - 1,800 m asl in West, Central and East Java. In Bromo Tengger Semeru forest, *A. acuminatissima* can grow up to 25 m in height. *A. acuminatissima* grows patchly in Ranu Pani and its surrounding area at 2,000-2,200 m asl. They grow mixed with some secondary forest trees along Ngadas to Jemplang. According to the respondents, this species is rarely used as civil material due to the low quality of the wood.

Casuarina junghuhniana Miq.

Casuarinaceae. *C. junghuhniana* is considered native to Eastern Java and Lesser Sundas Islands (Nusa Tenggara). This species is naturally found in mountain volcanic slopes at 1,500 -3,100 m asl. (Hanum & van der Maesen, 1997). According to van Steenis (1972), it plays an important role in mountain forest succession. It is known as a fire resistant plant and considered a pioneer species in degraded lands and volcanic ash and sand. In Tengger, *C. junghuhniana* is one of the species which is intensively used by the local people and considered a multipurpose tree species. *C. junghuhniana* provides good wood for civil construction. People also prefer to collect *C. junghuhniana* as charcoal and fuel wood (Heyne, 1987). In an area surrounding the restoration sites, this species is abundant in Ngadas, Jemplang, Ranupani and northern slopes of Mt. Semeru. According to the informants, it is one of the fuel wood sources for people in Tengger Highland. Wood heat is common among Tenggerese in Tengger Highland. Biologically, *C. junghuhniana* is one of the fast-growing trees species in Tengger and, therefore, plays an important role in the initial stages of restoration program in Ranupani Area.

Dacrycarpus imbricatus (Blume) de Laub

Podocarpaceae. Geographically, *D. imbricatus* is distributed across Java, Lesser Sundas and central Celebes. This species grows at altitude of 1,000-2,500 m asl (De Laubenfels, 1972). In Bromo Tengger Semeru, *D. imbricatus* (locally called Jamuju) is very rare and difficult to find in primary and secondary forest. There were only small populations in Ngadas and Ranupani mostly in secondary forest. Some individuals grow solitary and there are no seedling and juvenile individuals found. According to the respondents, in the past there were many individuals of Jamuju in forest area, but nowadays the population is decreasing. The wood of Jamuju has been known as one of the high-quality wood for many purposes. Therefore, it is easy to understand that in the past it became the target for illegal logging.

Engelhardtia spicata Blume

Juglandaceae. This species is distributed in India, China, and Southeast Asia regions (Thailand, Laos, Malaysia, the Philippines, Sumatra, Java, Kalimantan, Lesser Sundas Islands). Local people call it Danglu/Kukrup. Backer & van den Brink (1965) consider *E. spicata* as one of the pioneer species in mountainous ecosystem. In two observed plots, these trees grow up to 25 m. According to the respondents, the quality of the wood is weak and, therefore, is rarely used for civil construction. The reproduction rate of *E. spicata* in the field is considered high. It is very easy to find seedling in the wild, particularly in the forest area where *E. spicata* is abundant. In Bromo Tengger Semeru, this species can be found everywhere, particularly in sub-climax forest in Ngadas and Ranupani. The characteristics of its reproduction makes this species important in the initial steps of reintroduction program in restoration areas.

Myrsine korthalsii Miq.

Myrsinaceae. Local people call it Irengan. Backer & van den Brink (1965) report that this species grows in Mt. Slamet (central Java) and Mt. Arjuno (East Java) at mountain forest less than 3,090 m asl. Only a few papers have reported this species, making the information about *M. korthalsii* rare. In Bromo Tengger Semeru, it grows at 1,500-2,200 m asl. Trees of this species grow patchy mostly in secondary forest. Many of them grow solitary and some form small populations. There are no economic benefits generated from this species.

Lithocarpus sundaicus (Blume) Rehder

Fagaceae. *L. sundaicus* is native to the tropical parts of Asia, particularly Thailand, Malaysia, the Philippines and western Indonesia (Sumatra, Java and Kalimantan Islands). The species grows in primary forest in Malesia region at 1,000-1,500 m asl. In Java, it is commonly found in West Java, but scattered in East Java (Soepadmo, 1972). Tenggerese people call *L. sundaicus* Pasang Putih. It has been recognized as one of the species with high-quality wood for many purposes, particularly for civil construction. The respondents state that the good quality of such wood leads to *L. sundaicus* exploitation in the wild. Heyne (1987) states that the wood of *L. sundaicus* is one of the good wood for civil constructions (houses, bridges, ...).

Lithocarpus korthalsii (Endl.) Soepadmo

Fagaceae. Local people call this species Pasang Merah, Pasang Susu, or Pasang Kapur. Soepadmo (1972) notes that the species is distributed in Malesia region. Lemmens et al. (1995) report that this species grows in lowland to mountain forest in Sumatra and Java Islands. In Java it could be found in west to east parts. In Bromo Tengger Semeru, this species is found from 1,800 to 2,200 m asl, as big trees. This species is considered important as material for civil construction (Heyne, 1987).

Macropanax dispermum (Bl.) Kuntze.

Araliaceae. In Malesia this species grows at Sumatra, Malay Peninsula and Java, particularly central and eastern parts of Java. Beyond Malesian phytogeographic region, this species is found in India, Burma and southern China (Philipson, 1979). Naturally it is able to grow at 1,000-2,300 m asl. In Java, it is distributed at west, central and east parts, particularly in mountainous areas. This species is reported to prefer humid environments (Backer & van den Brink, 1965) and can be found everywhere in humid forest areas in the northern slopes of Mt. Semeru at 1,500-2,200 m asl. Local people call it Pampung or Endog-endogan. According to the informants, the species is abundant in the forest and relatively undisturbed by local people. This species is very easy to propagate through vegetative propagation by stem cuttings techniques. Individual trees can reach 18 m in height. It is not mentioned as useful plant (Heyne, 1987).

Omalanthus giganteus Z. & M.

Euphorbiaceae. This species is reported by van Steenis (1972) to be distributed in Java mountain, particularly in the eastern part of the island. Interestingly, it is considered rare and absent in the western part of Java. Ecologically, this species is a pioneer species in tropical mountainous forest. It is one of the fast-growing trees. In the study area it is able to survive under pressure of its competitors such as *Eupatorium odoratum* L. and *E. riparium* Regel (Asteraceae). The respondents argue that the wood cannot be used for civil construction and other purposes.

Astronia spectabilis Bl.

Melastomataceae. Locally called Kayu Ampet or Gembirung, in Indonesia this species is distributed from west to east Java. It is also found in Bali Island in humid tropical forest. Naturally, it is found at 1,300-2,500 m asl. In Bromo Tengger Semeru, this species is found in some areas, particularly in humid tropical forest at 1,500 to 2,200 m asl. Individual trees can reach 20 m in height (Backer & van den Brink, 1965), but in Ranupani it can reach 25-30 m. The respondents state that the wood of *A. spectabilis* can be used for houses and civil construction.

Trema orientalis (L.) Blume

Ulmaceae. This species is native to Africa, Asia Temperate, Asia Tropical and Australasia (Soepadmo, 1977). Local people call it Angrung. It grows below

2,400 m asl, and is considered as a fast-growing tree species in tropical forest. According to the respondents, there are still abundant Angrung populations in the national park area. Although the wood durability is considered low, the wood of Angrung still is the most important material for civil constructions in some villages around Mt. Semeru. Heyne (1987) points out that there are many ethnobotanical applications of *Trema orientalis*. However, the ethnobotanical application of *T. orientalis* is not recorded in this study, indicating that the people in Tengger do not use such species for any cultural purposes.

Turpinia sphaerocarpa Hassk.

Staphyleaceae. This species is distributed in Malesia region, particularly in the rainy forests (van der Linden, 1960). *T. sphaerocarpa* is distributed in West, Central and East Java at 20-2,200 m asl (Backer & van den Brink, 1965). Interestingly, there are no populations reported from New Guinea. Local people call it Kayu Bangkong. *T. sphaerocarpa* produces soft wood. In Java, the wood of *T. sphaerocarpa* is used for furniture, but is not durable for civil construction (Heyne, 1987). In Tengger highland, it grows as shrubs and trees.

Other species found and mentioned by the respondents are *Albizia montana* (Jungh.) Benth. (Fabaceae), *Helicia* sp., *Saurauia pendula* Bl. (Actinidiaceae), *Manglietia glauca* Blume (Magnoliaceae), and *Litsea diversifolia* Blume. (Lauraceae). *Albizia montana* is rarely found in Ranupani and rarely collected by local people as fuel wood. However, two informants state that in the past *A. montana* was also cut and collected as fuel wood. In Ranupani area *A. montana* grows in small populations and mixes into the shrubby areas which are dominated by exotic species such as *Eupatorium odoratum*. *A. montana* is one of the significant species in early succession stages and, therefore, should be considered to be planned in the first step of restoration program in Ranupani.

Some of the trees mentioned above play an important role as pioneer species, i.e. *Engelhardia spicata* Lesch. ex Blume (Juglandaceae), *Omalanthus giganteus* Z. & M. (Euphorbiaceae), *Astronia spectabilis* Blume (Melastomataceae), *Trema orientalis* (L.) Blume (Cannabaceae) and *Casuarina junghuhniana*. In many degraded places in the national park area, some seedling and juvenile individuals of such species grow under high pressure of *Eupatorium odoratum* and some grass species. They can be a potential candidate for assisting the natural succession programs in Ranupani area. In the first step of the restoration program, these species can be planted with some pioneer shrubs and herbs such as *Dodonaea viscosa* Jacq. (Sapindaceae), *Myrica javanica* Blume (Myricaceae), *Pittosporum moluccanum* (Lam.) Miq. (Pittosporaceae) and *Buddleja asiatica* Lour. (Scrophulariaceae). This could be an effective combination design for the beginning of restoration program in degraded lands in Ranupani area. Other potential plant species for the restoration program in Ranupani area include *Acer laurinum*, *Acmena acuminatissima*, *Dacrycarpus imbricatus*, *Myrsine korthalsii*, *Lithocarpus sundaicus*, *L. korthalsii*, *Macropanax dispermu* and *Turpinia sphaerocarpa*.

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REFERENCES

Aronson J., Milton S.J. & Blignaut J.N., 2007. Restoring natural capital: Science, Business and Practices. Island Press, Washington, 384 pp.

Backer C.A. & van den Brink R.C.B., 1965. Flora of Java. N.V.P. Noordhoff, Groningen.

De Laubenfels D.J., 1972. *Dacrycarpus*. In: van Steenis C.G.G.J. (Ed.), Flora Malesiana, Series I: Spermathophyta (Flowering Plants). NHN, Leiden, Vol. 10, (3), pp. 374-384.

Falk D.A., Millar C.I. & Olwell M., 1996. Restoring diversity: Strategies for reintroduction of endangered plants. Island Press, Washington, 505 pp.

Hakim L., 2011. Cultural landscapes of the Tengger Highland, East Java. In: Hong, S.K., Wu, J., Kim, J.E.

& N. Nakagoshi (Eds.), Landscape ecology in Asian cultures, Springer Verlag, Tokyo, pp. 69-82.

Hakim L., Retnaningdyah C., Sunaryo &Yanuwiadi B., 2011. Project on capacity building for restoration of ecosystem in conservation area: basic survey for Ranu Pani - Ranu Regulo restoration project. Malang: JICA- Ministry of Forestry- Dept. of Biology Brawijaya University- Bromo Tengger Semeru National Park, Malang.

Hakim L., Soemarno M. & Hong S.-K., 2012. Challenges for conserving biodiversity and developing sustainable island tourism in North Sulawesi Province, Indonesia. Journal of Ecology and Field Biology, 35: 61-71.

Hanum F.I. & van der Maesen L.J.G., 1997. Prosea. Plant Resources of South-East Asia, Vol. 11. Backhuys Publishers, Leiden, 389 pp.

Heyne K., 1987. Tumbuhan berguna Indonesia. Badan Litbang Kehutanan, Departemen Kehutanan, Jakarta.

Lemmens R.H.M.J, Soerjanegara I. & Wong W.C., 1995. Prosea. Plant resources of South-East Asia, Vol. 5 (3). Backhuys Publishers, Leiden, 655 pp.

Lowry W.R., 2009. Repairing paradise: the restoration of nature in America's National Parks. Brookings Institution Press, Washington, 287 pp.

Miyakawa H., 2010. Peninjauan kembali pedoman pemerintah tentang restorasi ekosistems pada kawasan konservasi. Project on capacity building for restoration of ecosystem in conservation area. JICA- Ministry of Forestry Indonesia, Jakarta.

MoE., 2005. State of the environment in Indonesia. Ministry of Environment, Jakarta.

Phillips A., 1996. The challenge of restoring Europe's nature and landscapes. International Planning Studies, 1: 73-93.

Philipson W., 1979. *Macropanax*. In: van Steenis C.G.G.J. (Ed.), Flora Malesiana, Series I: Spermathophyta (Flowering Plants). NHN, Leiden, Vol. 9, (1), pp. 86-89.

Salim E., 2002. Indonesian forest and people in Change. In: Colfer J.C.P. & Resosudarmo I.A.P. (Eds.), Which way forward? People, forest, and policymaking in Indonesia. RFF Press Book, Washington, 433 pp.

Soepadmo E., 1972. *Lithocarpus*. In: van Steenis C.G.G.J. (Ed.), Flora Malesiana, Series I: Spermathophyta (Flowering Plants). NHN, Leiden, Vol. 7 (2), pp. 318-385.

Soepadmo E., 1977. *Trema*. In: van Steenis C.G.G.J. (Ed.), Flora Malesiana, Series I: Spermathophyta (Flowering Plants). NHN, Leiden, Vol. 8 (2), pp. 47-55.

Sosef M.S.M., Hong L.T. & Prawirohatmodjo S., 1998. Timber tress: Lesser-known timbers. Prosea. Plant resources of South-East Asia, Vol. 5 (2).

van Steenis C.G.G.J., 1972. The mountain flora of Java. E.J. Brill, Leiden, 147 pp.

van der Linden B.L., 1960 Staphyleaceae. In: Van Steenis C.G.G.J. (Ed.) Flora Malesiana, Series I: Spermathophyta (Flowering Plants). NHN, Leiden, Vol. 6 (1), pp. 49-59.

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New distribution record of *Boucerosia diffusa* Wight (Gentianales Apocynaceae) in the Southern Western Ghats, India

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ABSTRACT The presence of *Boucerosia diffusa* Wight (Gentianales Apocynaceae) in the foothills of Southern Western Ghats at Pechiparai, Kanyakumari Wildlife Sanctuary (India) is reported. This succulent asclepiad is frequently treated as *Caralluma diffusa* (Wight) N.E.Br. by many researchers. Present paper is the first record of the occurrence of this species in Kanyakumari Wildlife Sanctuary and the second in the southern Western Ghats.

KEY WORDS Apocynaceae; *Boucerosia diffusa*; *Caralluma diffusa*; Kanyakumari; Wildlife Sanctuary.

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INTRODUCTION

Stapeliads are an attractive group of succulent asclepiads lending aesthetic beauty to rocky crevices and dry hills with assorted and delightfully ornamented flowers (Karuppusamy et al., 2013). They are represented by ca. 30 genera with 400 species of fleshy succulent plants, including several genera among which *Boucerosia* Wight & Walker-Arnott and *Caralluma* Brown. The genus *Caralluma*, commonly known as antiobesity plants was first named by Brown R. (1810) to describe an Indian species, *Caralluma adscendens*, with very characteristic elongated flowering succulent stem. Wight & Walker-Arnott (1834) split the genus and described two new genera *Boucerosia* and *Hutchinia*. In 1892, Brown N.E. compiled all related genera under the genus *Caralluma*. Schuman (1895) tried to divide the genus *Caralluma* into three sections: *Eucaralluma* K. Schum (= *Caralluma*), *Lalacruma* K. Schum and *Boucerosia*. Plowes (1995) believed that the taxonomy of the genus *Caralluma* had full of species in dust-bin and it could not be fitted into other existing genera. He segregated the genus *Caralluma* into 17 different genera. According to Plowes (1995), Indian species of *Caralluma* fall into 4 categories (*Caralluma*, *Cryptolluma* Plowes, *Boucerosia* and *Borealluma* Plowes). Meve & Liede (2002) tried to solve the taxonomic problem of the tribe Ceropegiae using modern tools of molecular phylogeny. They suggested clearly that the Indian genus *Caralluma* can be segregated into four groups: *Boucerosia*, *Caralluma*, *Caudanthera* Meve et Liede and *Apteranthes* Meve et Liede. However, the genus *Boucerosia* has been completely ignored and it has been treated as synonym of *Caralluma* by taxonomists, since the genus is restricted to Southern India, Sri Lanka and Myanmar.

Boucerosia include succulent plants with leafless erect, trailing or decumbent stems, with/without ephemeral vestigial leaves. This genus is different from the genus *Caralluma* mainly due to the presence of umbellate terminal cymes. The genus is represented by 8 species in India. Of these,

Boucerosia crenulata (Wall.) Wight et Arn., *B. diffusa* Wight, *B. indica* (Wight et Arn.) Plowes, *B. pauciflora* Wight, *B. procumbens* (Gravely et Mayur.) Plowes, and *B. truncato-coronata* (Sedgw.) Gravely et Mayur) have been reported from Tamil Nadu state with the exception of *B. lasiantha*, which has been reported only from some localities of Andhra Pradesh and Kerala states, India. While reviewing the literature, the genus *Boucerosia* has been reported to have two species (*B. procumbens* and *B. umbellata*) from Kanyakumari district.

During a floristic exploration of Kanyakumari Wildlife Sanctuary at Pechiparai (N 08° 24.364', E 077°17.960'; altitude 497 ft/151.49 m), we collected a succulent plant with flowers in the terminal umbel belonging to the genus *Boucerosia* (tribe Ceropegiae, subfamily Asclepiadoideae and family Apocynaceae). After critical study and matching with available herbarium specimens, it was identified as *B. diffusa* (Fig. 1). Even after repeated explorations we could locate only one population of this species in the study area. The population has only 5 patches and the total area of occurrence was approximately 0.2 ha. As far as we are aware, none of the published literature (Sukumaran & Jeeva, 2008; Samuel et al., 2008; Sukumaran et al., 2008; Karuppusamy, 2011; Brintha et al., 2012) on the plant diversity of Kanyakumari district reported the occurrence of this species. Therefore, it is reported here with details such as distribution, brief description, habitat, phenological data, specimens examined in other Herbaria and biotic association. The voucher specimens are deposited at the Herbarium of Scott Christian College, Nagercoil, Tamil Nadu, India.

Boucerosia diffusa Wight

Boucerosia diffusa Wight, Icon. Pl. Ind. Orient. 4: 14, 1599, 1850. Hooker f. Fl. Brit. India, 4: 78, 1885. Plowes in Haseltonia, 3: 59, 1995. Meve & Liede in Plant Syst. Evol., 234: 200, 2002. Karuppusamy et al., *Caralluma*, 79-85, 2013. *Caralluma diffusa* (Wight) N. E. Br. in Gard. Chron., 12: 369, 1892. Gamble & Fischer, Fl. Pres. Madras, 2: 862, 1923. Gravely & Mayuranathan in Bull. Madr. Govt. Mus. n.s. N.H., 4: 25-26, 1931. S.R. Srinivasan in Henry et al., Fl. Tamil Nadu Analy, 2: 81, 1987. Gilbert in Bradleya, 8:16, 1990. Jagtap & Singh in Fasc. Fl. India, 24: 200, 1999. Ramachandran et al., in J. Threatened Taxa, 3: 1622, 2011. Kumar et al., 2013 in Ind. Forester, 139: 425-428.

EXAMINED MATERIAL. India, Tamil Nadu, Kanyakumari district, Pechiparai forest, 12.IV.2013, coll. S. Sukumaran and S. Jeeva #1220 (SCCH - Herbarium of Scott Christian College, Nagercoil). Specimen consulted. The collected succulent was matched with authentic herbarium specimens available at CAL, Kolkata, C.E.C. Fischer 2258, Coimbatore district, Kalpatti Atamalai slope, 1850 ft, 28.IX.1910; MH, Coimbatore, C.P. Sreemadhavan 136, slope of Anamalai, 650 m, 31.VIII.1962; Slope of Karupparayan Hills near Coimbatore, 31.X.1963, C.P. Sreemadhavan 957 m (MH); SKU, Ananthapur. Ugraiah (31752), Thiruvannamalai district, Arthanaareeswarar Sacred Hill, 4.VIII.2008.

DESCRIPTION. Stems fleshy, branched; branches erect, stout, 75 cm tall, four-angled, nearly equal thickness throughout; internodes 6-12 mm long and 5-15 mm in thickness, glabrous. Leaves absent, leaf scars present, appendage like growth at nodes on angle portions. Flowers many, terminal, in umbellate cymes, usually 30-35-flowered; bracts ca. 1.5 mm long and 1.0-1.5 mm in diam., glabrous. Calyx 5-lobed, divided up to base, surface of the lobes hairless, but the dark streaks are minutely papillose, lobes ca 3 × 1 mm, lanceolate, apex acute, glabrous. Corolla campanulate, ca 2.5 mm dia.; corolla tube ca 5 mm long; lobes 5, ca 3 × 2 cm, ovate, apex acute, margin ciliate, glabrous. Corona staminal, biseriate; outer annular, arising from the base of stamens, closely intact, five lobed, ca 2.5 × 1.5 mm, with two horn-like appendages widely separated from each other; inner variable, ca 1 mm long, linear, arising from the inner side of outer corona, overlapping anther-lobes. Stamens 5, ca. 2.5 mm long; pollinia masses solitary in each anther cell, yellow, waxy, with pellucid layer attached by a light-brown caudicles and dark-brown corpuscle. Gynostegium ca 1.5 mm long. Follicles paired, linear-lanceolate, tapering towards apex, glabrous. Seeds glabrous, 7-10 × 3-3.5 mm, oblong, base rounded, margin dark brown, coma silky, 3-5 cm long.

DISTRIBUTION. In India, *Boucerosia diffusa* has so far been reported from the southern state of Tamil Nadu alone. It is distributed in Madukkarai Hills of Coimbatore (Ramachandran et al., 2011) and Thiruvannamalai districts of Tamil Nadu (Karuppusamy et al., 2013). Recently, Kumar et al. (2013) reported this species from the Chinnar Wildlife Sanctuary in the Western Ghats of Kerala. Our collections record its presence for the first time in the southern Western Ghats of Kanyakumari district. These findings imply that our knowledge of a

plant's distribution, i.e. 'endemism' is prone to change when more and more botanical explorations are undertaken at the regional/national level. So far, this species had been known to be endemic in Coimbatore and Thiruvannamalai district; because of its recent report from the Chinnar Wildlife Sanctuary, Kerala and also from the far end of southern Western Ghats, i.e. Kanyakumari Wildlife Sanctuary, the species may be stated as endemic to Tamil Nadu and Kerala states of south India.

Figure 1. *Boucerosia diffusa* Wight.

BIOLOGY. *B. diffusa* is found to grow as lithophyte on the rocky slopes of fragmented hillocks situated inside forest patches converted into rubber plantation. Biotic association: *B. diffusa* is associated with species such as *Catharanthus pusillus* (Murray) G. Don., *Cissus quadrangularis* L., *Drynaria quercifolia* (L.) J. Sm., *Eulophia graminifolia* Lindl., *Sansevieria roxburghiana* Schult. et Schult.f., etc. Pollination: this species is generally pollinated by small scadophagous, dipterans and perhaps also by beetles (Stevens, 1976). Flowering and fruiting: April-September.

ETYMOLOGY. The species was first collected by Robert Wight, and named by him as *Boucerosia diffusa*, from Coimbatore in 1850. In Latin '*diffusa*' means loosely spreading; the branches of the plants are found to be loosely spreading on the ground. The vernacular name is: Paarai Kalli (Rock growing cactus) in Tamil.

REMARKS. Conservation: Gamble & Fischer (1923) gave the distribution of *Caralluma diffusa* as Deccan, arid rocky hills near Coimbatore at an elevation of about 600 m. Henry et al. (1979) stated that 'No specimens of *Caralluma diffusa* had been deposited in MH'. It is one of the endemic species occurring in Coimbatore district. Srinivasan (1987) also indicated in Flora of Tamil Nadu that its distribution is only from Coimbatore district in Tamil Nadu and its status mentioned as 'rare and threatened'. Nadu et al. (1999) considered this species to be endemic to Tamil Nadu. Rao et al. (2003) indicated its status to be 'indeterminate'. This species is now under heavy biotic pressure, since it is present in a hillock situated in the forest area converted into rubber plantation; it is doubtful whether the existing population will survive, as the species possesses economic and ethnobotanical importance too. Ex situ conservation of this vulnerable endemic taxon in rockery, greenhouses and gardens, besides its re-introduction into the wild in similar habitats is the need of the hour. The other issues to be prioritized are inventorying and monitoring of plant diversity in unexplored areas, assessment of conservation status of species and roles of species in ecosystems.

Economic importance: the succulent stem of this species is used as sustenance of an indigenous community. It is often eaten in many different forms: cooked with salt and spices as an everyday vegetable, utilized in preserves like pickles and chutneys and eaten raw. The local people of Madukkarai hills use the sap of young stems to treat obesity. Moreover, the genus is medicinally important as it shows diverse medicinal properties like analgesic, anthelmintic, antiarthritic, antigastric ulcer, antiatherosclerotic, antibacterial, antihyperglycemic, anti-inflammatory, antinociceptive, antitrypanosomal, antirheumatic, antitumour, appetite suppressant, antiobesity, antioxidant, cytoprotective, immunostimulating.

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REFERENCES

Brintha T.S.S., James J.E. & Jeeva S., 2012. Floristic spectrum of Scott Christian College Campus, Nagercoil, Tamilnadu, India. Sciencia Acta Xaveriana, 3: 162-166.

Brown N.E., 1892. *Caralluma campanulata* (with an enumeration of the other species of the genus, and description of several). Gardener's Chronicle, 12: 369-370.

Brown R., 1810. On the Ascelepiadeae, a natural order of plants separated from the Apocineae of Jussieu. Memoirs of the Wernerian Natural History Society, 1: 12-78.

Gamble J.S. & Fischer C.E.C., 1923. Flora of the Presidency of Madras. Newman and Adlard, London. Reprint Vol II, 1957. Botanical Survey of India, Calcutta, 862 pp.

Gilbert M.G., 1990. A review of *Caralluma* R. Br. and its segregates. Bradleya, 8: 1-32.

Gravely F.H. & Mayuranathan P.V.P., 1931. The Indian species of the genus *Caralluma* (Fam. Asclepiadaceae). Bulletin of Madras Government Museum, 4: 1-28.

Henry A.N., Kumari G.R. & Chitra V., 1987. Flora of Tamil Nadu, Series 1 - Analysis, Vol. 2. Botanical Survey of India, Coimbatore, 258 pp.

Henry A.N., Vivekananthan K. & Nair N.C., 1979. Rare and threatened flowering plants of South India. Journal of the Bombay Natural History Society, 75: 684-697.

Hooker J. D., 1885. The flora of British India, Vol. 4. Great Britain.

Jagtap A.P. & Singh N.P., 1999. Fascicles of Flora of India. Fascicle 24. Botanical Survey of India, Calcutta, 332 pp.

Karuppusamy S., Ugraiah A. & Pullaiah T., 2013. *Caralluma* (Sensu Lato): Antiobesity Plants. Astral International Private Limited, New Delhi, 203 pp.

Karuppusamy S., 2011. Notes on the Stapeliad genus *Boucerosia* (Asclepiadaceae) of South Peninsular India. Aloe, 48: 18-22.

Kumar K.M.P., George S., Sreedhar S. & Balachandran I., 2013. *Caralluma diffusa* (Wight) N.E.Br. (Apocynaceae) - a new distribution record for Kerala from Chinnar Wildlife Sanctuary, India. The Indian Forester, 139: 425-428.

Meve U. & Liede S., 2002. A molecular phylogeny and generic rearrangement of the Stapelioid Ceropegieae (Apocynaceae - Asclepiadoideae). Plant Systematics and Evolution, 234: 171-209.

Nadu T., Chithra V. & Nair V.J., 1999. Floristic Diversity and Conservation Strategies in India. In the Context of States and Union territories. Botanical Survey of India, Ministry of Environment and Forests, Kolkata, 1451-1510 pp.

Plowes D.C.H., 1995. A reclassification of *Caralluma* R. Brown. (Stapelieae: Asclepiadaceae). Haseltonia, 3: 49-70.

Ramachandran V.S., Thomas B., Sofiya C. & Sasi R., 2011. Rediscovery of an endemic plant *Caralluma diffusa* (Wight) N.E. Br. (Asclepiadaceae) from Coimbatore District, Tamil Nadu, India, after 160 years. Journal of Threatened Taxa, 3: 1622-1623.

Rao C.K., Geetha B.L. & Suresh G., 2003. Red List of Threatened Vascular Plant Species in India. Compiled from the 1997 IUCN Red List of Threatened Plants, ENVIS, Botanical Survey of India, Ministry of Environment & Forests, Kolkata, 129 pp.

Samuel D.P., Nair P.K.K. & Kumar R.P., 2008. Endemic flora of Marunduvalmalai hills of southern Western Ghats, Kanyakumari district - India. Journal of Basic and Applied Biology, 2: 39-46.

Schumann K., 1895. Asclepiadaceae. In: Engler H.G.A. & Prantl K.A.E. (Ed.). Die Natürlichen Plflanzenfamilien, Vol. 4 (2). Wilhelm Engelmann, Leipzig, pp. 189-306.

Srinivasan S.R., 1987. Asclepiadaceae. In: Henry A.N., Kumari G.R. & Chithra V. (Eds.). Flora of Tamil Nadu, S. I: Analysis, Vol. 2: 81. Botanical Survey of India, Coimbatore, 258 pp.

Stevens W.D., 1976. Asclepiadaceae. In: Saldanha C.J. & Nicolson D.H. (Eds.). Flora of Hassan District, Karnataka, India. Amerind Publishing Co. Pvt. Ltd., New Delhi, 923 pp.

Sukumaran S. & Jeeva S., 2008. A floristic study on miniature sacred forests at Agastheeshwaram, southern peninsular India. EurAsian Journal of Biosciences, 2: 66-72.

Sukumaran S., Jeeva S., Raj A.D.S. & Kannan D., 2008. Floristic Diversity, conservation status and economic value of miniature sacred groves in Kanyakumari district, Tamil Nadu, Southern Peninsular India. Turkish Journal of Botany, 32: 185-199.

Wight R. & Walker-Arnott G.A., 1834. In: Wight R. (Ed.), Contributions to the Botany of India. Allen & Co., Parbury, 480 pp.

Wight R., 1850. Icones Plantarum Indiae orientalis, or figures of indian plants, Vol. 1. Pharoah, Madras, 318 pp.

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Diversity of freshwater benthos in the ecotourism area at Chiang Dao District in Chiang Mai Province, Thailand

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ABSTRACT The diversity of benthic diatoms and aquatic insects in the ecotourism areas of Mea Lu and Tong Ta Streams at Chiang Dao District in Chiang Mai Province in the north of Thailand were investigated during the months of July and September 2012 and January 2013, from the upper, middle and lower parts of each stream. A total of 53 taxa of benthic diatoms and 46 families of aquatic insects were found. Forty-seven and thirty-one taxa of benthic diatoms were found from the Mea Lu and Tong Ta Streams, respectively. Thirty-eight and twenty-eight families of aquatic insects were found from the Mea Lu and Tong Ta Streams, respectively. The diversity index of benthic diatoms ranged from 1.17 to 2.66, while the aquatic insects ranged from 0 to 2.14. In the upstream sites of this study, a high abundance of benthic diatoms, such as *Navicula cryptotenella*, *Planothidium rostratum* and *Planothidium lanceolatum*, and aquatic insects, such as Caenidae and Elmidae, were found. At the downstream sites, a high abundance of benthic diatoms, such as *Nitzschia palea* and *Mayamaea atomus* and aquatic insects, such as Corixidae, Baetidae, Chironomidae, Simuliidae and Hydropsychidae, were found.

KEY WORDS Benthic diatoms; Aquatic insects; Diversity index; Ping River.

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INTRODUCTION

At present, ecotourism has become popular in many countries. Nevertheless, no further detailed studies have been conducted on the biodiversity of freshwater benthos in the ecotourism areas around the world. This is true for Thailand too, with the exception of several studies dealing with a few groups of animals and plants (Hvenegaard & Dearden, 1998; Chettamart & Emphandhu, 2002; Lyndon & Yongvanit, 2005; Chayamarit & Puff, 2007a,b; Jaroensutasinee et al., 2011; Krailas et al., 2012).

Thailand has many ecotourism areas, such as Doi Inthanon National Park, Phukradung National Park, Khao Yai National Park and Kaeng Krachen National Park, as well as Doi Chiang Dao National Park (also called Doi Luang) at Chiang Dao District in Chiang Mai Province. This district comprises the area in which Ping River originates, which is the main river of Thailand and was first awarded with the title of "ecotourism district" in the Northern Thailand in the year 2011.

The aim of the study was to determine the diversity of freshwater benthos in the ecotourism area at Chiang Dao District in Chiang Mai Province, comprising Mea Lu (ML) and Tong Ta (TT) Streams. In addition, this research study presents the first report of diversity of freshwater benthos, including benthic diatoms and aquatic insects, in the ecotourism area in the north of Thailand.

MATERIALS AND METHODS

The samples were collected from two streams at the ecotourism areas, including Mea Lu (ML) and Tong Ta (TT) Streams, which are located in the upstream area of Ping River at Chiang Dao District in Chiang Mai Province, Thailand. The benthos samples, including benthic diatoms and aquatic insects, were collected in July and September 2012 and January 2013 from the upper, middle and lower parts of each stream (Fig. 1 and Table 1).

Benthic diatom samples were scraped off from 5 stones (or other hard substrates) at each site. In the laboratory, the samples were cleaned by the concentrated acid digestion method and prepared on permanent slides (Renberg, 1990; Kelly et al., 1998; Leelahakriengkrai & Peerapornpisal, 2011). The samples were identified and counted according to Krammer & Lange-Bertalot (1986, 1988, 1991a,b), Lange-Bertalot (2001), and Kelly & Haworth (2002).

Aquatic insects samples were collected by the kick sampling method with a D-frame net (800 μm meshes) and preserved in 70% ethanol (Furse et al., 1981; Arimoro & Ikomi, 2009). In the laboratory, only the aquatic insects were separated, identified and counted according to McCafferty (1983), Merritt et al. (2009), Stehr (1991), Dudgeon (1992), Wiggins (1996) and Sangpradub & Boonsoong (2006).

Sampling site	GPS (Lat-Long)	Altitude (m)
ML1	N 19°25'31.178" E 098°56'48.618"	489
ML2	N 19°25'07.819" E 098°56'53.287"	478
ML3	N 19°24'36.048" E 098°57'07.377"	463
TT1	N 19°5'31.261" E 098°56'49.058"	491
TT2	N 19°24'56.805" E 098°57'06.718"	460
TT3	N 19°24'42.124" E 098°57'15.150"	452

Table 1. Sampling sites and their topography.

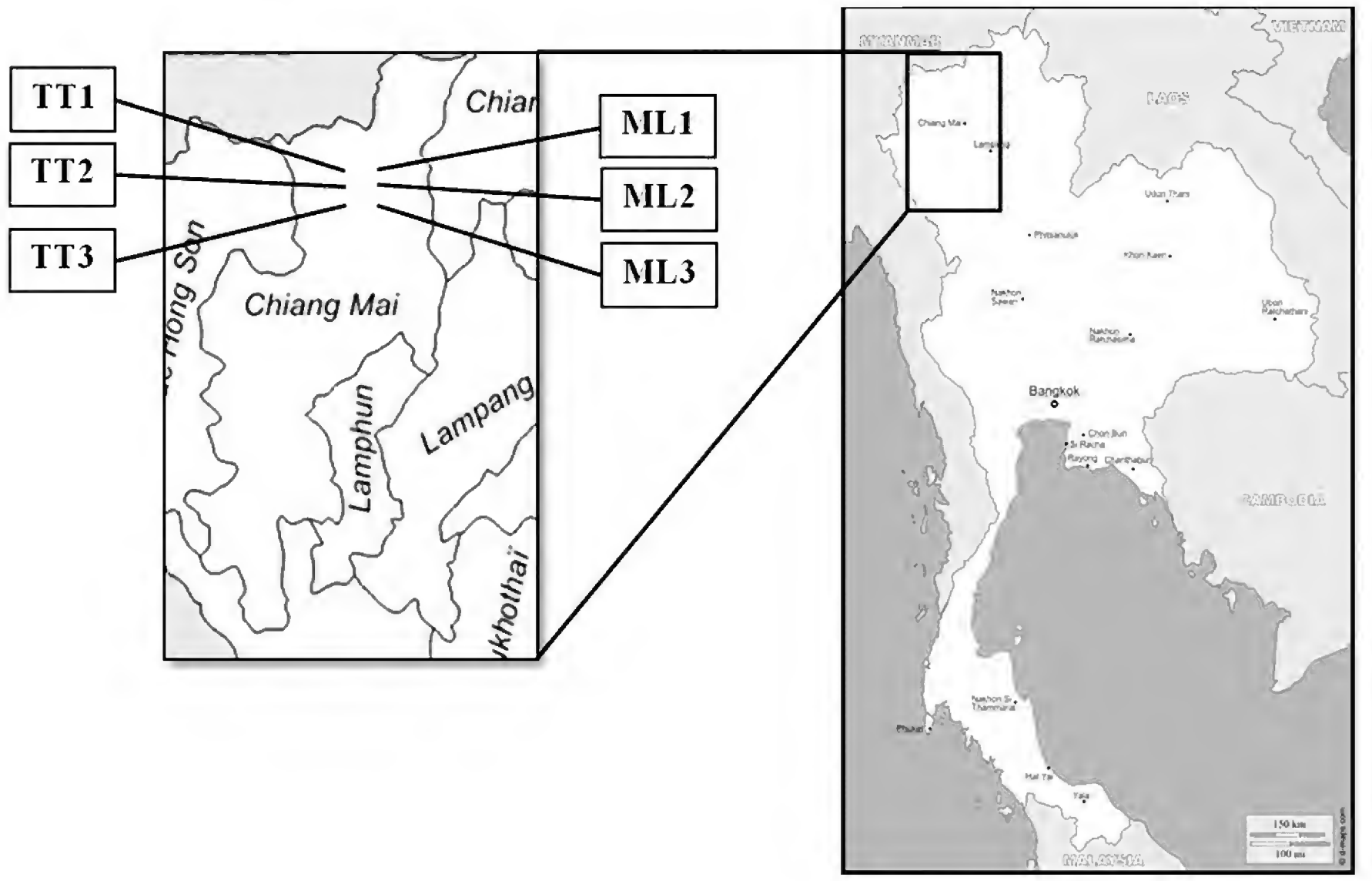

Figure 1. Map showing location of the six sampling sites in Mea Lu (ML) and Tong Ta (TT) streams at Chiang Dao district, Chiang Mai province, Thailand.

The species diversity index (H') and evenness (E) of benthic diatoms and aquatic insects were calculated following the Shannon Diversity Index (Odum, 2005).

RESULTS AND DISCUSSION

A total of nineteen families and fifty-three taxa of benthic diatoms from the Mea Lu and Tong Ta Streams were classified into 2 classes, according to Round et al. (1990), Coscinodiscophyceae, and Bacillariophyceae in Division Bacillariophyta. Forty-seven taxa of benthic diatoms were found from the Mea Lu Stream and thirty-one species were collected from the Tong Ta Stream (Table 2). In the upstream sites of this study, a high abundance of *Navicula cryptotenella*, *Planothidium rostratum* and *Planothidium lanceolatum* was found, similarly to what reported in Asia by Tien (2004), Atazadeh et al. (2007) and Suphan & Peerapornpisal (2010), who found the same dominant species in Erh-Jen River (China), Gharasou River (Iran) and Mekong River and its tributaries. It appears that the species

Family	Species	ML1	ML2	ML3	TT1	TT2	TT3
Stephanodiscaceae	*Cyclotella meneghiniana*	-	-/-/+	-	-	-	-
	Cyclotella pseudostelligera	-	-	-/-/+	-	-	-
Achnanthaceae	*Achnanthes oblongella*	-/+/+	+/-/+	-	+/-/-	+/+/+	+/+/+
	Achnanthes brevipes	-	-	-	+/-/-	+/-/+	+/+/-
	Planothidium lanceolata	+/+*/+*	+/+/+	+/+/+*	+*/-/+	+/+/+*	+/+/+
	Planothidium rostratum	+/+/+*	+/+/+	+/-/+	+*/-/-	-/-/+	-/+/+
	Planothidium sp.	-	-/-/+	-	-	-	-
Cocconeidaceae	*Cocconeis placentula*	+/+/+	+/-/+	+/-/+	-/-/+	-/-/+	-/+/+
Cymbellaceae	*Cymbella turgidula*	-	-	-/+/+	-	+/+/+	+/-/-
	Cymbella tumida	+/-/-	-	-/+/-	+/-/-	+/-/+	+/-/-
	Encyonema sp.	-	+/-/-	-	-	-/-/+	-
Eunotiaceae	*Eunotia bilunaris*	-	+/-/-	-	-	-	-/+/-
Gomphonemataceae	*Gomphonema gracile*	+/-/-	-	-	-	-	-
	Gomphonema lagenula	-	+*/-/+	+/+/+	+/-/+	+/+/+	+/-/+
	Gomphonema parvulum	-	-	-	+/-/+	-/-/+	-/+/+
Diadesmidaceae	*Luticola goeppertiana*	-	-/-/+*	-	-	-/-/+*	+/+/+
Amphipleuraceae	*Frustulia vulgaris*	-/-/+	-	-	-	-	-
Brachysiraceae	*Brachysira neoexilis*	-	-/-/+	-	-	-	-
Sellaphoraceae	*Sellaphora pupula*	-/-/+	-/-/+	+/-/+	-	-	-
Pinnulariaceae	*Pinnularia divergens*	-/-/+	-	-/+/-	-	-	-
	Pinnularia mesolepta	-	-	-/+/-	-	-	-
	Pinnularia sp.1	-	-	+/+/-	-	-	-
	Pinnularia sp.2	-	-	-/+/-	-	-	-
Diploneidaceae	*Diploneis oblongella*	+/+/+	-/+/+	-	+/+/+	-/-/+	+/-/+

Table 2. Species list of benthic diatoms in the Mea Lu and Tong Ta streams
(+ = present; - = absent in July 2012/September 2012/January 2013/ respectively; * = dominant).

FAMILY	SPECIES	ML1	ML2	ML3	TT1	TT2	TT3
Naviculaceae	*Adlafia* sp.		-/+/+	-/+/+			
	Mayamaea atomus	-/+/+	+*/+*/+*	+*/+*/+*	-	-	-
	Navicula viridula	-/-/+	-/-/+	+/+/+	+/+/+	+/-/+	-/+/-
	Navicula cryptocephala	-	-	-	+/-/-	+/+/+*	+/+/-
	Navicula cryptotenella	+*/+/+*	+*/+/+*	+/+*/-	+*/+*/-	+/+/+*	+/+*/+
	Navicula germainii	-/+/-	-/+/-	+/+*/+*	-/-/+	-/-/+	-/+/+
	Navicula phyllepta	+/+/-	+/-/+	-/+/+	-/-/+	-/+/+	-/+/+
	Navicula capitatoradiata	+/-/+	-/-/+	-/+*/+*	+/-/-	-/-/+	-/+/+
	Navicula symmetrica	-	-	-	-	-/-/+	-/+/-
	Navicula rostellata	-	+/-/+	+/+/+*	-	-/-/+	-/-/+
	Navicula tridentula	+/-/-	-/+/-	-	-	-	-
	Navicula erifuga	-/-/+	-/-/+	-/+/+	-	-	-
Neidiaceae	*Neidium binodis*	-/-/+	-	-	-	-	-
Pleurosigmataceae	*Gyrosigma spencerii*	-/+/+	-	+/+/+	-/-/+	-	-/+/+
	Gyrosigma scalproides	-/+/+	-	-/+/-	-/-/+	-	-/+/+
Stauroneidaceae	*Craticula molestiformis*	-	-	-	+/+/-	+/-/+	-/+/+
	Stauroneis smithii	-/-/+	-	-	-/-/+	-	+/+/-
	Stauroneis kriegeri	-	-	-	+/-/-	-/+/+	-/-/+
Catenulaceae	*Amphora montana*	-	-	-/+/-		+/-/+	-/+/-
Bacillariaceae	*Nitzschia amphibia*	-/-/+	+/-/-	+/-/-	-	-	-
	Nitzschia clausii	-	-/-/+	-/+/-	-	-	-
	Nitzschia coarctata	-/-/+	-	-	-	-	-
	Nitzschia levidensis	-/+/-	-	+/-/-	-	-	-
	Nitzschia palea	+/+/+	+/+/+	+*/+*/+*	+/-/+	+/+/+	+*/+*/+*
	Nitzschia dissipata	-	-	+/-/-	+/-/+	-	-/-/+
	Nitzschia sp.	-/-/+	-	+/-/-	-/+/-	-	-
Surirellaceae	*Surirella angusta*	-	-/-/+	+/-/-	+/-/-	-/-/+	
	Surirella splendida	-	-	+/-/-	-	-	-
	Surirella sp.	-/-/+	-	+/-/-	-	-	-

Table 2 (continued). Species list of benthic diatoms in the Mea Lu and Tong Ta streams
(+ = present; - = absent in July 2012/September 2012/January 2013/ respectively; * = dominant).

in moderate water quality could be considered as mesotrophic species. At the downstream sites, *Nitzschia palea* and *Mayamaea atomus* were found to be the dominant species, as in Jüttner et al. (2003), Stenger-Kovács et al. (2007), Duong et al. (2007) and García et al. (2008). They all reported the finding of these species in the downstream sites, which indicates tolerance to organic pollution.

A total of forty-six families of aquatic insects from the Mea Lu and Tong Ta Streams were classi-

ORDER	FAMILY	ML1	ML2	ML3	TT1	TT2	TT3
Odonata	Gomphidae	+/+/-	-	-	+/-/-	-	-
	Corduliidae	-/+/+	-/-/+	-	+/-/-	-	-
	Coenagrioniidae	-	+/-/-	+/+/+	+/-/-	+/-/-	+/-/-
	Macromiidae	-	-	-	-	-	+/-/-
	Protoneuridae	-	+/-/-	-/+/-	-	+/-/-	-/-/+
	Libellulidae	-	--	+/-/-	-	+/-/+	+/-/-
	Aeshnidae	+/-/-	+/-/-	-	-	-	+/-/-
	Chlorocyphidae	-	-	+/-/+	-/-/+	-/-/+	-/-/+
	Platystictidae	-	-	-/+/-	-	-	-/-/+
	Euphaeidae	-/-/+	-	-	-	-	-
	Calopterygidae	-	+/-/+	-	-	-	-
Coleoptera	Elminthidae	-	-	-	+/-/-	-/+/-	-
	Scirtidae	+/-/-	-	-	+/-/-	-	-
	Dytiscidae	-	-	-	-	-	-/-/+
	Dryopidae	+/-/-	-	-	-	-	-
	Psephenidae	+/-/-	-	-	-	-	-
	Elmidae	+*/+/+	-/+/-	+/-/-	-	-	-
	Gyrinidae	-	+/-/-	+/-/-	-	-	-
	Hydrophilidae	-	-/+/-	-/+/-	-	-	-
Diptera	Chironomidae	-/+/-	+/+*/+	+*/+/+	+/+/-	+/+/+	-/+/-
	Athericidae	+/-/+	-	-	+/-/+	-	-
	Simuliidae	-/+/-	-/+/-	-	-/-/+	+/+*/+	-
	Tipulidae	-/+/+	-	-	-	-/+/-	-
	Stratiomyidae	-/+/-	+/-/-	+/-/-	-	-	-
	Ceratopogonidae	-	-/+/-	-	-	-	-
Ephemeroptera	Ephemeridae	+/-/-	-	-/-/+	+/-/+	-	-/-/+
	Caenidae	+*/-/+	-/+/+	+/+/+*	+*/-/+	+/-/+	+/+/+
	Beatidae	-/+/+	-/+/+	+*/+/+	-/-/+	+*/+*/+*	-/+*/+*
	Leptophlebiidae	-	-		-	-	-/-/+
	Neoephemeridae	+/-/-	-	-/-/+	-	-	-
	Heptageniidae	-/-/+	-	-	-	-	-
Trichoptera	Odontoceridae	+/-/-	-/+/-	-	+/-/-	-	-
	Hydropsychidae	+/+/+	-/+/-	-/-/+	-/-/+	-/+*/-	-/+/+
	Hydroptilidae	-	-	-	-	-	-/+/-
	Ecnomidae	-	-	-	-	-	-/-/+
	Molannidae	+/-/-	-	-	-	-	-
	Calamoceratidae	+/-/-	-	-	-	-	-
	Brachycentridae	-/-/+	-	-	-	-	-
	Leptoceridae	-	+/+/+	-	-	-	-
	Limnephilidae	-	-/+/-	-	-	-	-
Hemiptera	Gerridae	+/-/+	-/-/+	-/+/+	-	+/-/-	+/+/-
	Nepidae	-	-	-	-	-	+/-/-
	Veliidae	-	-/+/+*	-	-/-/+	-/-/+	-
	Mesoveliidae	-	-	-	-	-/-/+	-
	Naucoridae	-/+/-	-	-	-	-	-
	Corixidae	-	+*/-/+	+/+/-	-	-	-

Table 3. Families list of aquatic insects in the Mea Lu and Tong Ta streams
(+ = present; - = absent in July 2012/September 2012/January 2013/ respectively; * = dominant).

	BENTHIC DIATOMS				AQUATIC INSECTS		
Month	**Sampling site**	**Diversity Index**	**Evenness**	**Species number**	**Diversity Index**	**Evenness**	**Family number**
July 2012	ML1	1.80	0.75	11	1.89	0.70	15
	ML2	1.17	0.41	17	1.94	0.84	10
	ML3	1.87	0.59	24	2.14	0.89	11
	TT1	2.55	0.81	23	2.06	0.89	10
	TT2	2.03	0.82	12	0	0	1
	TT3	2.62	0.94	16	1.92	0.87	9
September 2012	ML1	2.14	0.77	16	0.15	0.07	9
	ML2	1.53	0.73	8	1.78	0.72	12
	ML3	2.14	0.69	22	1.56	0.71	9
	TT1	1.54	0.86	6	1.35	0.65	8
	TT2	1.93	0.78	12	0.92	0.52	6
	TT3	2.54	0.76	28	1.25	0.6	8
January 2013	ML1	2.1	0.64	26	1.44	0.62	10
	ML2	2.12	0.68	22	1.75	0.80	9
	ML3	2.15	0.76	17	0.99	0.45	9
	TT1	2.63	0.93	17	1.3	0.67	7
	TT2	2.66	0.78	31	0.92	0.51	6
	TT3	2.53	0.79	25	1.66	0.67	12

Table 4. Shannon's diversity index, evenness and the number of benthic diatoms in Mea Lu (ML) and Tong Ta (TT) streams.

fied into 6 orders; Ephemeroptera, Hemiptera, Diptera, Coleoptera, Odonata and Trichoptera. Thirty-eight families of aquatic insects were collected from the Mea Lu Stream and twenty-eight families from the Tong Ta Stream (Table 3). In the upstream sites, a high abundance of Caenidae and Elmidae was found, which are known to be sensitive to organic pollution and commonly found in locations under high dissolved oxygen conditions. Moreover, at the downstream sites, Corixidae, Baetidae, Chironomidae, Simuliidae and Hydropsychidae were found, which are known to possess tolerance to organic pollution and are commonly found in locations under low dissolved oxygen conditions (Mustow, 2002; Sharma et al, 2005; Mary & Macrina, 2012).

Shannon's diversity index, evenness and the number of benthic diatoms and aquatic insects in the Mea Lu and Tong Ta Streams are shown in Table 4. The diversity index of benthic diatoms ranged from 1.17 to 2.66 and the evenness ranged from 0.41to 0.94 and number of species varied from 6 to 31. In TT2, where a total of 31 species were present, the highest diversity index of 2.66 (evenness 0.78) was recorded on January 2013. Also in other sampling sites a high diversity rate was recorded in January 2013, during the cool dry season. The sampling sites which reflected a low rate of diversity index were mostly found in the ML2. The diversity index of aquatic insects ranged from 0 to 2.14 and the evenness ranged from 0 to 0.89, while the number of families varied from 1 to 15. In ML3, where a total of 11 families were present, the highest diversity index of 2.14 (evenness 0.89) was recorded on July 2012; in TT1, a high rate of the diversity index was recorded on July 2012 (diversity index 2.06, evenness 0.89).

In conclusion, the diversity of benthos in the ecotourism area including the Mea Lu and Tong Ta Streams, revealed very little difference compared to the diversity reports from Europe and Asia. In addition, this study revealed the sensitivity and tolerance of benthos to organic pollution in the upstream and downstream areas, respectively. Finally, this research study represents the first report of the diversity of freshwater benthos, including benthic diatoms and aquatic insects, in the ecotourism areas in the north of Thailand to produce the database collection that can be used for other study areas.

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REFERENCES

Arimoro F.O. & Ikomi R.B., 2009. Ecological integrity of upper Warri River using aquatic insects as bioindicators. Ecological Indicators, 9: 455-461.

Atazadeh I. Sharifi M. & Kelly M.G., 2007. Evaluation of the trophic diatom index for assessing water quality in river Gharasou, Western Iran. Hydrobiologia, 589: 165-173.

Chayamarit K. & Puff C., 2007a. Plants of Doi Inthanon National Park, National Park, Wildlife and Plant Conservation Department, Bangkok, Thailand, 224 pp.

Chayamarit K. & Puff C., 2007b. Plants of Kaeng Krachen National Park, National Park, Wildlife and Plant Conservation Department, Bangkok, Thailand, 202 pp.

Chettamart S. & Emphandhu D., 2002. Experience with Coastal and Marine Protected Area Planning and Management in Thailand, Environmental Protection and Rural Development in Thailand: Challenges and Opportunities, White Lotus Press, Bangkok, Thailand, pp. 113-136.

Dudgeon D., 1992. Patterns and Processes in Stream Ecology, Asynoptic Review of Hong Kong Running Water, Schweizerbart'scheverlags buchhandlung, Stuttgart, Germany, 147 pp.

Duong T., Mazel A., Coste M., Dang D. & Boudou A., 2007. Dynamics of diatom colonization process in some rivers influenced by urban pollution (Hanoi, Vietnam). Ecological Indicators, 7: 839-851.

Furse M.T., Wright J.F., Armitage P.D. & Moss D., 1981. An appraisal of pond-net samples for biological monitoring of lotic macro-invertebrates. Water Research, 15: 679-689.

García L., Delgado C. & Pardo I., 2008. Seasonal changes of benthic communities in a temporary stream of Ibiza (Balearic Islands). Limnetica, 27: 259-272.

Hvenegaard G.T. & Dearden P., 1998. Ecotourism versus tourism in a Thai national park. Annals of Tourism Research, 25: 700-720.

Jaroensutasinee M., Pheera W., Ninlaeard R., Jaroensutasinee K. & Choldumrongkul S., 2011. Weather affecting macro-moth diversity at Khao Nan National Park, Thailand. Walailak Journal of Science and Technology, 8: 21-31.

Jüttner I., Sharma S., Dahal B.M., Ormerod S.J., Chimonides P.J. & Cox E.J., 2003. Diatoms as indicators of stream quality in the Kathmandu Valley and middle hills of Nepal and India. Freshwater Biology, 48: 2065-2084.

Kelly M.G. & Haworth E.Y., 2002. The Fresh Water Algae Flora of the British Isles. Cambridge University Press, Cambridge, United Kingdom, 714 pp.

Kelly M.G., Cazaubon A., Coring E., Dell'Uomo A., Ector L., Goldsmith B., Guasch H., Hürlimann J., Jarlman A., Kawecka B., Kwandrans J., Laugaste R., Lindstrøm E.A., Leitao M., Marvan P., Padisák J., Pipp E., Prygiel J., Rott E., Sabater S., van Dam H. & Vizinet J., 1998. Recommendations for routine sampling of diatoms for water quality assessments in Europe. Journal of Applied Phycology, 10: 215-224.

Krailas D., Chotesaengsri S., Dechruksa W., Namchote S., Chuanprasit C., Veeravechsukij N., Boonmekam D., & Koonchornboon T., 2012. Species diversity of aquatic mollusks and their cercarial infections; Khao Yai National Park, Thailand. The Journal of Tropical Medicine and Parasitology, 35: 37-47.

Krammer K. & Lange-Bertalot H., 1986. Bacillariophyceae, 1, Teil: Naviculaceae, In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D. (Eds.), Süsswasserflora von Mitteleuropa, Band 2/1, Gustav Fisher Verlag, Stuttgart, Germany, 876 pp.

Krammer K. & Lange-Bertalot H., 1988. Bacillariophyceae, 2, Teil: Bacillariaceae, Epithemiaceae and Surirellaceae, In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D. (Eds.), Süsswasserflora von Mitteleuropa, Band 2/2. Gustav Fisher Verlag, Stuttgart, Germany, 596 pp.

Krammer K. & Lange-Bertalot H., 1991a. Bacillariophyceae, 3, Teil: Centrales, Fragilariaceae and Eunotiaceae, In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D. (Eds.), Süsswasserflora von Mitteleuropa, Band 2/3, Gustav Fisher Verlag, Stuttgart, Germany, 576 pp.

Krammer K. & Lange-Bertalot H., 1991b. Bacillariophyceae, 4, Teil: Achnanthaceae, In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D. (Eds.), Süsswasser-

flora von Mitteleuropa, Band 2/4, Gustav Fisher Verlag, Stuttgart, Germany, 437 pp.

Lange-Bertalot H., 2001. Diatoms of Europe, Koeltz Scientific Books, Stuttgart, Germany, 526 pp.

Leelahakriengkrai P. & Peerapornpisal Y., 2011. Diversity of benthic diatoms in six main rivers of Thailand. International Journal of Agriculture and Biology, 13: 309-316.

Lyndon W. & Yongvanit S., 2005. Farmers, foresters and forest temples: conservation in the Dong Mun uplands, Northeast Thailand. Geoforum, 36: 735-749.

Mary L.F. & Macrina T.Z., 2012. Macro invertebrate composition, diversity and richness in relation to the water quality status of Mananga River, Cebu, Philippines. Philippine Science Letters, 5: 103-113.

McCafferty W.P., 1983. Aquatic Entomology, Jones and Bartlett Publishers Inc., Boston, USA, 448 pp.

Merritt W.R., Cummins W.K. & Berg M.B., 2009. An Introduction to the Aquatic Insects of North America, 4th edition, Kendall/Hunt Publishing, Dubuque, Iowa, USA, 1214 pp.

Mustow S.E. 2002. Biological monitoring of river in Thailand: Use and Adaptation of the BMWP score. Hydrobiologia, 479: 191-299.

Odum E.P., 2005. Fundamental of Ecology, 5th edition, Saunders, W.B. Philadelphia, USA, 574 pp.

Round F., Crawford R. & Mann D., 1990. The Diatoms. Biology & morphology of the genera. Cambridge University Press, 747 pp.

Renberg I., 1990. A procedure for preparing large sets of diatom slides from sediment cores. Journal of Paleolimnology, 4: 87-90.

Sangpradub N. & Boonsoong B., 2006. Identification of freshwater invertebrates of the Mekong River and its tributaries, Mekong River Commission, Vientiane, Lao P.D.R., 274 pp.

Sharma S., Allen M., Courage A., Hall H., Koirala S., Oliver S. & Zimmerman B., 2005. Assessing water quality for ecosystem health of the Babai river in Royal Bardai National Park, Nepal. Kathmandu University Journal of Science, Engineering and Technology, 1: 1-13.

Stehr F.W., 1991. Immature Insects, vol. 2, Kendall/Hunt Publishing, Dubuque, Iowa, USA, 992 pp.

Stenger-Kovács C., Buczkó K., Hajnal E. & Padisák J., 2007. Epiphytic, littoral diatoms as bioindicators of shallow lake trophic status: Trophic Diatom Index for Lakes (TDIL) developed in Hungary. Hydrobiologia, 589:141-154.

Suphan S. & Peerapornpisal Y., 2010. Fifty three new record species of benthic diatoms from Mekong River and its tributaries in Thailand. Chiang Mai Journal of Science, 37: 326-343.

Tien C.J., 2004. Some aspects of water quality in a polluted lowland river in relation to the intracellular chemical levels in planktonic and epilithic diatoms. Water Resources, 38: 1779-1790.

Wiggins G.B., 1996. Larvae of the North American Caddisfly Genera (Trichoptera), 2nd edition, University of Toronto Press, Canada, 457 pp.

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New species of *Agrilus* Curtis, 1825 belonging to the subgenus *Nigritius* Curletti, 1998 from Ethiopic Region (Coleoptera Buprestidae Agrilini)

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ABSTRACT Four new W African species are described: *Agrilus* (*Nigritius*) *massaronei* n. sp. from Gabon, *Agrilus* (*Nigritius*) *yangambii* n. sp. from Congo Democratic Republic, *Agrilus* (*Nigritius*) *ivorianus* n. sp. and *Agrilus* (*Nigritius*) *bancoi* n. sp. both from Ivory Coast.

KEY WORDS Buprestidae; *Agrilus*; *Nigritius*; new species; Africa.

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INTRODUCTION

The study of material obtained from an entomological expedition in Gabon in the February 2012 organized by the Museum of Calimera, Lecce, Italy (abbreviation: MSNS), showed the presence of a new species that is described here. On this occasion a further three new species conserved for a long time in the collections of the Museum of Carmagnola, Turin, Italy (abbreviation: MCCI) are also described.

All species treated in this work belong to the genus *Agrilus* Curtis, 1821 (Coleoptera Buprestidae) subgenus *Nigritius* Curletti, 1988, including those examined for comparison (Kerremans, 1903; Obenberger, 1831; Théry, 1947; Curletti, 1998). The specimens are preserved dry, the pictures were obtained with a Coolpix P6000 connected with a stereomicroscope Leica MZ6 and elaborated in stacking with Adob Photoshop CS5 Extended vers. 12.0.

DESCRIPTION OF THE SPECIES

Agrilus (*Nigritius*) *massaronei* n. sp.

EXAMINED MATERIAL. Holotypus female (Figs. 1, 2): Gabon, Ogooué, Ivindo, 500 m, P.N. Ivindo, Station de Recherche d'Ipassa, 0°30'43"N-12°48'12"E, 16-29.II.2012, C. Massarone leg. (MSNS).

DESCRIPTION OF HOLOTYPUS. Length 12.3 mm. Dorsal color uniformly black. Vertex furrowed in middle, 1/3 of the anterior edge of pronotum, with obsolete and thin punctuation. Frons black, glabrous, with exception of white, brilliant pubescence at the base, covering also the clypeus. Two wide superficial depressions in the upper part. Clypeus without transverse carina. Antennae black, serrate from fourth antennomere. Pronotum wider in middle, with lateral edges few arcuate, subparallel, but with posterior angles strongly sinuate and acute. Disc convex, regular transversal striae. Premarginal carinula brief but well evident. Yellow gold pubescence covering the integument at the lateral sides. Lateral carinae joined at the base. Prosternal plate rhomboidal. Scutellum wide and short, with strong transverse carina. Elytra glabrous; apex with a strong tip in middle. Lateroterga with uniform yellow gold pubescence, well visible from the top. Abdominal sterna with the same pubescence of the lateroterga. Legs black, with all claws dentate.

Metatarsus shorter than metatibia; basal article longer than the sum of the following three (1>2+3+4).

ETIMOLOGY. After the name of the collector, the colleague Carlo Massarone (Italy).

REMARKS. Given that the majority of species belonging to the subgenus *Nigritius* Curletti, 1998 is composed by species of big size, elongated, and black dorsal color, *A. massaronei* n. sp. is characterized by elytra glabrous, premarginal carinula not entire, presence of apical tips, uniform yellow pubescence on lateroterga and sterna. Among this group, *A. massaronei* n. sp. is near to *A. cernus* Obenberger, 1931 described from Cameroun. I know two syntypes of this species, one male in Tervuren Museum (Belgium) and one (sex not identified) in Prague Museum (Czech Republic), that may be two distinct species, because the specimen from Tervuren lacks of the tips at the elytral apex. Anyway both *A. cernus* specimens differ for having smaller dimensions (9.1 and 9.5 mm in length), yellow pubescence also on humeral callus and on middle of the frons, vertex sculpture composed by striae and not punctiform, posterior angles of pronotum obtuse without sinuosity before these angles, metatarsus long as the metafemur. The type specimen was found together with two specimens of *Agrilus* (*Nigritius*) *alluaudi* Kerremans, 1903; this species has the same pattern of yellow pubescence, but differs principally for having premarginal carinula entire and elytral apex acuminate, without tips.

Agrilus* (*Nigritius*) *ivorianus n. sp.

EXAMINED MATERIAL. Holotypus female (Figs. 3, 4): Côte d'Ivoire, forêt de Banco, XII.1986, Ture leg. (MCCI).

DESCRIPTION OF HOLOTYPUS. Length 11.8 mm. Head black, pronotum green, elytra green in median anterior part, dark brown posteriorly. Vertex width about 1/3 of anterior margin of pronotum, flat, smooth, with obsolete punctiform sculpture. Frons dark green, clypeus without carina. Antennae bronze, serrate from 4th antennomere. Pronotum wider anteriorly, with lateral margins regularly narrowed behind, but with basal angles acute. Disc with transverse thickened sculpture. Premarginal carinula not entire, in bold relief. Lateral carinae welded to the base. Anterior margin of prosternal lobe widely sinuous. Scutellum wide and short, strongly carinate. Elytra with pubescence gray, short, but well visible, slightly thickened in middle. Elytral apices with a median tip. Ventral side dark bronze with red reflections: sternites with a spot of yellow ocher pubescence on the sides. Lateroterga with the same spots placed in correspondence of those present on sternites. Green legs, all the claws simply dentate. Metatarsus longer than metatibia, with the basal metatarsomere longer than the sum of the following four (1>2+3+4+5).

ETIMOLOGY. After Ivory Coast, the country of locus typicus.

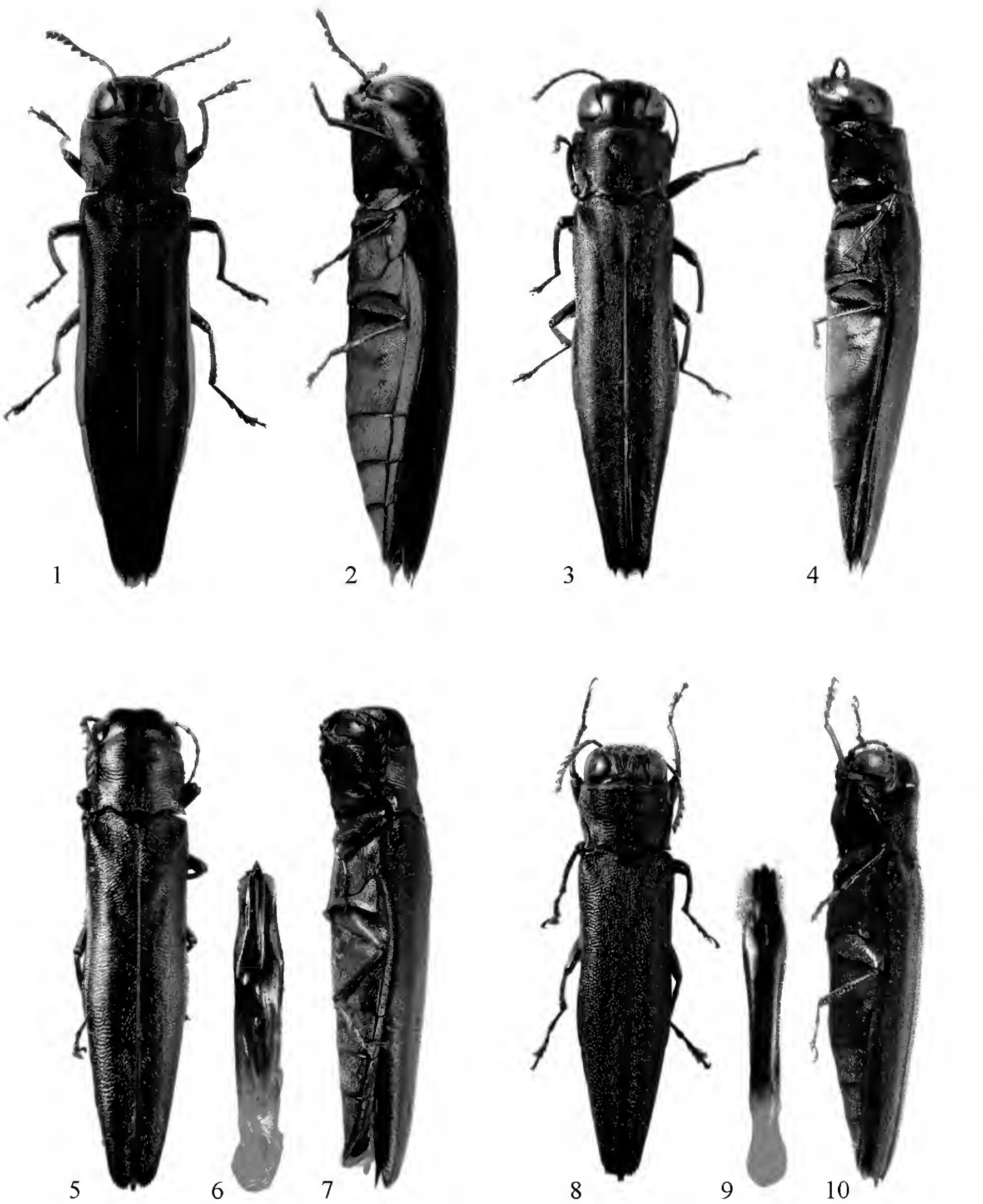
REMARKS. The sum of the characters of body color, elytral pubescence, apical tips, ventral spots is unique among the subgenus *Nigritius*.

Agrilus* (*Nigritius*) *yangambii n. sp.

EXAMINED MATERIAL. Holotypus male (Figs. 5-7): Congo, Yangambi, 1953 (MCCI).

DESCRIPTION OF HOLOTYPUS. Length 9 mm. Head black, pronotum brown, elytra black. Vertex protruding, similar to species belonging to subgenus *Robertius* Théry, 1947, furrowed in middle, with longitudinal sculpture. Frons green, flat, hardly sculptured, glabrous with exception of a line of brown coasts along the eyes. Clypeus separated from frons by a transversal carina. Antennae green-bronze, serrate from article 4. Pronotum wider anteriorly, then sinuate before the base, with anterior angles obtuse. Disc with regular transverse sculpture. Premarginal carinula entire. Lateral carinae separated from the base. Anterior margin of prosternal lobe amply sinuate. Scutellum transversely carinate. Elytra with vertex rounded and denticulate. White pubescence visible at 1/3 of apex only, along the suture. Ventral side bronzed, scattered with uniform brief white pubescence not covering the integuments. Apex of last visible sternite rounded. Legs bronze, anterior claws bifid, median and posterior simply dentate. Metatarsus shorter than metatibia; basal metatarsomere little longer than the sum of the following three (1>2+3+4). Aedeagus big, sclerotized, long and parallel, with median lobe acute (Fig. 6).

ETIMOLOGY. After the name of the locus typicus.



Figures 1, 2. *Agrilus* (*Nigritius*) *massaronei* n. sp., holotypus female, length 12.3 mm. Figures 3, 4. *Agrilus* (*Nigritius*) *ivorianus* n. sp., holotypus female, length 11.8 mm. Figures 5-7. *Agrilus (Nigritius) yangambii* n. sp., holotypus male, length 9 mm, with aedeagus (Fig. 6). Figures 8-10. *Agrilus (Nigritius) bancoi* n. sp., holotypus male, length 6.9 mm, with aedeagus (Fig. 9).

REMARKS. Among *Nigritius* species having head remembering the subgenus *Robertius* and having pubescence at elytral apex only, it is know *A. luebanus* Obenberger, 1931 only, described from Congo (type in Narodni Muzeum, Prague). *A. yangambii* n. sp. differs principally for having body less elongate, frons glabrous with different sculpture, premarginal carinula entire, basal metatarsomere less elongate.

Agrilus (Nigritius) bancoi n. sp.

EXAMINED MATERIAL. Holotypus male (Figs. 8-10): Côte d'Ivoire, forêt de Banco, XII.1986, Ture leg. (MCCI).

DESCRIPTION OF HOLOTYPUS. Length 6.9 mm. Dorsal color brown, entirely covered of grey/yellow pale pubescence more thickened along the elytral suture. Vertex flat, 1/3 the width of anterior margin of pronotum, with transverse hard sculpture. Frons green, furrowed, regularly pubescent. Clypeus carinate. Antennae serrate from 4th article; antennomeres 1-5 bronze, 6-11 green. Pronotum wider anteriorly, then sinuate before the posterior angles that are acute. Disc convex, with transverse regular striae. Premarginal carinula sturdy, prominent, entire. Marginal carinae joined before the base. Elytra with apex hardly denticulate. Ventral side and lateroterga uniformly pubescent: the pubescence not covering the integuments. Legs dark bronze-grey. Anterior and median claws bifid, posterior dentate. Metatarsus longer than metatibia. First metatarsomere shorter than the sum of the following three (1<2+3+4), but with the fifth longer than the sum of the third and fourth (5>3+4). Aedeagus elongate, little fusiform (Fig. 9).

ETIMOLOGY. After the type locality.

REMARKS. For the sum of dimensions added to elytral pubescence and the entire premarginal carinula, *A. bancoi* n. sp. is unmistakable among the subgenus *Nigritius*.

REFERENCES

Curletti G., 1998. Notes on metatarsal morphology in the genus *Agrilus* and a proposed redefinition of its subgenera in the afrotropical region (Coleoptera Buprestidae). Bollettino della Società Entomologica Italiana, 130: 124-134.

Kerremans C., 1903. Coleoptera Serricornia, Fam. Buprestidae. In: P. Wytsman. (Ed.). Genera Insectorum, Fasc. 12b; 12c; 12d. Verteneuil & Desmet, Bruxelles, pp. 49-338.

Obenberger J., 1931. Agrilenstudien I. (Col. Bupr.). Entomologisches Nachrichtenblatt 5: 54-71.

Théry A., 1947. Buprestides nouveaux (2.me note). The Annals and Magazine of Natural History (11) 13 (1946): 663-683.

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Two new records of cyprinid fish (Cypriniformes Cyprinidae) from Thailand

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ABSTRACT In the present paper, two cyprinid fishes, *Boraras urophthalmoides* (Kottelat, 1991) and *Rasbosoma spilocerca* (Rainboth et Kottelat, 1987) are newly recorded from Bangpakong Basin, Southeast Thailand. Description and distribution data of the two cyprinid fish are provided here.

KEY WORDS *Boraras urophthalmoides*; *Rasbosoma spilocerca*; Cyprinidae; Thailand.

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INTRODUCTION

Freshwater cyprinid fish genera *Boraras* Kottelat et Vidthayanon, 1993 and *Rasbosoma* Liao, Kullander et Fang, 2010 are scarcely distributed in Thailand. The genus *Boraras* has been reported for Southeast Asia only (Kottelat & Vidthayanon, 1993; Doi, 1997; Kottelat, 2001; Conway & Kottelat, 2011). According to the current taxonomic status of this genus, it comprises 6 valid species, *B. brigittae* (Vogt, 1978) and *B. merah* (Kottelat, 1991) from Borneo, Indonesia; *B. maculatus* (Duncker, 1904) from Malay Peninsula, Sumatra and Borneo, Indonesia; *B. micros* Kottelat et Vidthayanon, 1993 from Mekong Basin, Thailand and Laos; *B. naevus* Conway et Kottelat, 2011 from peninsular Thailand and *B. urophthalmoides* (Kottelat, 1991), from Sumatra, Malay Peninsula, Mekong Basin in Indochina, Lower Chao Phraya Basin and peninsular Thailand (Kottelat & Vidthayanon, 1993; Kottelat et al., 1993; Doi, 1997; Conway & Kottelat, 2011).

The genus *Rasbosoma* is distributed in Mekong Basin only (Indochina). First record of *R. spilocerca* (Rainboth et Kottelat, 1987) in Thailand was reported by Rainboth & Kottelat (1987) under the name *Rasbora spilocerca* from Mekong Basin at Northeast Thailand (Ubon Province, Kalasin Province and Udon Thani Province). Currently, this species was considered a junior synonym of *Rasbosoma spilocerca* (Rainboth & Kottelat, 1987; Rainboth, 1996; Vidthayanon et al., 1997; Liao et al., 2010).

In a survey project of the authors in Upper Bangpakong Basin, Southeast Thailand during October and November 2012, we found several specimens of *B. urophthalmoides* and one specimen of *R. spilocerca* from temporary peat-swamp of the tributary of Bangpakong River, Pakpee District, Nakhon Nayok Province, Southeast Thailand. This is a new record of *B. urophthalmoides* and *R. spilocerca* in Bangpakong Basin, Thailand. Currently, the specimens of *B. urophthalmoides* and *R. spilocerca* are deposited into the Reference Collection of Aquatic Biology, Ramkhamhaeng University, Bangkok, Thailand.

ACRONYMS AND ABBREVATIONS. Reference Collection of Aquatic Biology, Ramkhamhaeng University, Bangkok, Thailand = RU; standard length = SL; head length = HL.

RESULTS

Order Cypriniformes Bleeker, 1859
Family Cyprinidae Cuvier, 1817

Boraras urophthalmoides (Kottelat, 1991)

EXAMINED MATERIAL. RU 0093-0094, 35 specimens, 15-19 mm SL, Temporary peatswamp of Bangpakong Basin, Pakpee District, Nakhon Nayok Province, Southeastern Thailand (Fig. 1), X/XI. 2012, legit Nidsaraporn Petsut, Sitthi Kulabtong et Jiraweath Petsut.

DESCRIPTON. This species (Fig. 2) is distinguished from other species of genus *Boraras* by the combination of the following characters: large black prominent lateral stripe on each side of the body, the origin of which is behind the opercle and ending near the caudal peduncle; large black spot on each caudal fin base and anal fin base; the first dorsal-fin ray is black.

B. urophthalmoides is compressed, body depth is 26.6-29.3 %SL. Body width is 8.6-11.2 %SL. Scales in lateral series are medium to large, lateral series scales is made of 24-27 scales, predorsal scales are 10-12. Head length is 26.8-31.1 %SL. The eye is large, eye diameter is 35.7-37.9 %HL (8.6-11.1 %SL). Post orbital length is 43.8-46.4 %HL (10.1-14.6 %SL), snout length is short, with 17.9-20.1 %HL (5.0-7.1 %SL) and interorbital width is 46.9-50.4 % HL (10.9-11.8 % SL). Dorsal fin origin is anterior to the anal fin origin, predorsal fin length is 57.7-62.8 %SL, prepectoral fin length is 30.6-32.2 %SL, prepelvic fin length is 46.5-51.1 %SL and preanal fin length is 64.1-66.9 %SL. Caudal peduncle depth is 10.0-10.9 %SL. Pectoral fin is short not reaching beyond the anus, pectoral fin length is 14.3-16.2 %SL with 8-9 branched fin rays. Pelvic fin is short not reaching beyond the anus, pelvic fin length is 8.0-9.2 %SL with 7 branched fin rays. Anal fin base is longer than dorsal fin base, anal fin base length is 10.6-13.4 %SL, dorsal fin shows 2 unbranched rays and 7 branched rays and anal fin 3 unbranched rays and 5 branched rays. Dorsal fin base length is 8.3-9.5 %SL.

Coloration in fresh specimens is fade red, purple or orange along the body. On the side of body is clearly silver or light black showing a prominent lateral stripe from behind the opercle to pre-caudal peduncle. The stripe has a small orange frame. The spot on caudal fin base is silver or light black, with a small orange frame. The black spot on anal fin base is not clear. Anterior of dorsal fin is fade black and red, anal fin is transparent with fade black on the anterior part, caudal fin is transparent with red or orange on caudal fin base, pectoral fin and pelvic fin are transparent. Coloration in preserved specimens lost all of red, orange and purple on the body, caudal peduncle and all fins. On the side is clearly black with a prominent lateral stripe from behind the opercle to pre-caudal peduncle, large black spots on the caudal fin base and anal fin base.

DISTRIBUTION. This species is known from Sumatra, Malay Peninsula, Mekong Basin in Indochina, Lower Chao Phraya Basin and peninsular Thailand. New record for Bangpakong Basin.

Figure 1. Temporary peatswamp of Bangpakong Basin, Southeastern Thailand.

Rasbosoma spilocerca (Rainboth et Kottelat, 1987)

EXAMINED MATERIAL. RU 0090, 1 specimens, 24 mm SL, Temporary peatswamp of Bangpakong Basin, Pakpee District, Nakhon Nayok Province, Southeast Thailand, X/XI. 2012, legit Nidsaraporn Petsut, Sitthi Kulabtong et Jiraweath Petsut (Fig. 1).

DESCRIPTON. *R. spilocerca* is distinguished from

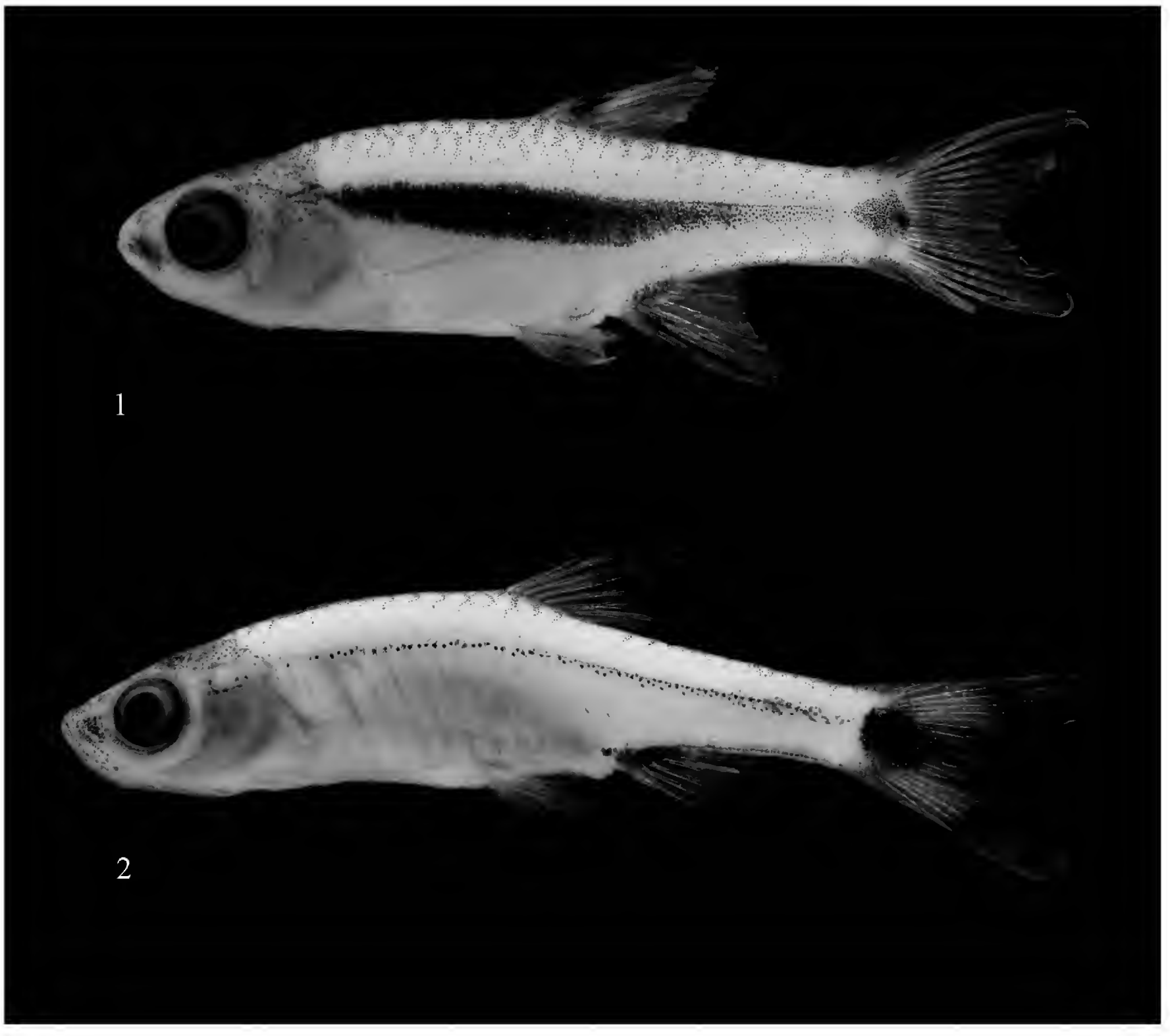

Figure 2. *Boraras urophthalmoides*, 15 mm SL from Bangpakong Basin, Thailand. Figure 3. *Rasbosoma spilocerca*, 24 mm SL from Bangpakong Basin, Thailand.

other species of rasborins by the tip of the outer arm of suspensorium bent inward, forming a short horizontal process (Kottelat & Vidthayanon, 1993). Lateraline scales incomplete and 9-10 circumpeduncular scales. Clearly black spot on dorsal fin, anal fin and caudal fin base.

R. spilocerca (Fig. 3) is compressed, body depth is 25.4 %SL. Body width is 10.8 %SL. Scales in lateral series are large, lateral series scales are 28, predorsal scales 12. Head length is 24.6 %SL. The eye is large, eye diameter is 31.4 %HL (7.8 %SL). Post orbital length is 45.4 %HL (11.5 %SL), snout length is short, with 22.9 %HL (5.6 %SL) and interorbital width is 48.6 % HL. Dorsal fin origin is posterior to the pelvic fin origin, predorsal fin length is 54.2 %SL, prepectoral fin length is 24.7 %SL, prepelvic fin length is 50.7 %SL and preanal fin length is 67.6 %SL. Caudal peduncle depth is 11.3 %SL. Pectoral fin is short not reaching beyond the anus, pectoral fin length is 15.5 %SL with 8 branched fin rays. Pelvic fin is short not reaching beyond the anus, pelvic fin length is 16.9 %SL bearing 7 branched fin rays. Anal fin base length is 9.9 %SL, dorsal fin with 3 unbranched rays and 7 branched rays. Dorsal fin base length is 12.1 %SL.

Coloration in fresh specimens is transparent along the body. On the side of body is clearly black with a lateral stripe from behind the opercle to precaudal peduncle and black spots on dorsal fin, anal fin and caudal fin base.

DISTRIBUTION. This species is recorded only in Mekong Basin, Indochina. New record for Bangpakong Basin.

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REFERENCES

Conway K.W. & Kottelat M., 2011. *Boraras naevus*, a new species of miniature and sexually dichromatic freshwater fish from peninsular Thailand (Ostariophysi: Cyprinidae). Zootaxa, 3002: 45-51.

Doi A., 1997. A review of taxonomic studies of cyprinform fishes in Southeast Asia. Japanese Journal of Ichthyology, 44: 1-33.

Kottelat M., 2001. Fishes of Laos. Wildlife Heritage Trust, Colombo, 198 pp.

Kottelat M. & Vidthayanon C., 1993. *Boraras micros*, a new genus and species of minute freshwater fish from Thailand (Teleostei: Cyprinidae). Ichthyological Exploration of Freshwaters, 4: 161-176.

Kottelat M., Whitten A.J., Kartikasari S.N. & Wirjoatmodjo S., 1993. Freshwater fishes of Western Indonesia and Sulawesi. Periplus Editions, Hong Kong, 259 pp.

Liao T.Y., Kullander S.O. & Fang F., 2010. Phylogenetic analysis of the genus *Rasbora* (Teleostei: Cyprinidae). Zoologica Scripta, 39: 155-176.

Rainboth W.J. & Kottelat M., 1987. *Rasbora spilocerca*, a new cyprinid from the Mekong River. Copeia, 2: 417-423.

Rainboth W.J., 1996. FAO species identification field guide for fishery purposes. Fishes of the Cambodian Mekong. Rome, FAO, 265 pp.

Vidthayanon C., Karnasuta J. & Nabhitabhata J., 1997. Diversity of freshwater fishes in Thailand. Office of Environmental Policy and Planning, Bangkok, 102 pp.

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New report of *Aperiovula juanjosensii* Pérez et Gómez, 1987 (Gastropoda Ovulidae) for the Sicilian coast

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ABSTRACT One living specimen of *Aperiovula juanjosensii* Pérez et Gómez, 1987 (Gastropoda Ovulidae) was found in the Strait of Messina (North-East Sicily), at Punta Faro at a depth of about 90 m. The specimen was found in the fishing rest, in a sample rich of *Myriapora truncata* (Pallas, 1776), but with presence of *Paramuricea clavata* (Risso, 1826) and *Eunicella cavolinii* (Esper, 1791). The gorgonian *Villogorgia bebrycoides* (Koch, 1887), indicated as host in literature, even if should be present in the area, has not been found. *A. juanjosensii* was described for the area of Canary Islands and Atlantic Marocco and, up to now, only shown for a location of the Italian coast, without additional data.

KEY WORDS *Aperiovula juanjosensii*; recent; Mediterranean Sea.

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INTRODUCTION

One specimen of *Aperiovula juanjosensii* Pérez et Gómez, 1987 (Gastropoda Ovulidae) was found in June 2013 in the rest of fishing material taken with trammel net laid down at a depth of about 90 m, at Punta Faro also called Capo Peloro (Strait of Messina, North-East Sicily).

The sample was rich of *Myriapora truncata* (Pallas, 1776), but were also present *Paramuricea clavata* (Risso, 1826) and *Eunicella cavolinii* (Esper, 1791). The specimen, complete of soft parts, is 7.8 mm high and 4.5 mm wide. The gorgonian *Villogorgia bebrycoides* (Koch, 1887), indicated as host in literature, even if should be present in the area, has not been found. This species was described for the area of Canary Islands and Atlantic Marocco, and, up to now, only shown for a location of the Italian coast, without additional data.

Aperiovula juanjosensii Pérez et Gómez, 1987

ORIGINAL DESCRIPTION (Pérez & Gómez, 1987). The general shape. The shell is pyriform in shape, not very solid, with extremely small apertures, slightly translucent, and small in size. The base is convex. The aperture is rather narrow with the columella and the lip being practically parallel. The latter has hardly accentuated denticles in the internal border, which terminate toward the anterior extremity. The funiculus is well marked. The posterior extremity is enlarged and pointed, with the sinus open and slightly curved toward the dorsal part. The lip border is clearly marked. The columella is

curved with an evident small depression and dimple. The syphon canal terminates obliquely (the external lip is shorter than the internal one).

The external surface. It is sculptured by transversal striae localized at both extremities, particularly on the posterior where they are more numerous and dense. The globular area of the final whorl has no spiral sculpture, except for some so fine that they are visible only upon microscopic examination.

Colouring. The colouring is bright white, almost translucent. On the lip borders at the extremities it takes on an opaque ivory shade. An exact description of the mollusc itself is not yet possible, but local fishermen have referred that it has a reddish tint.

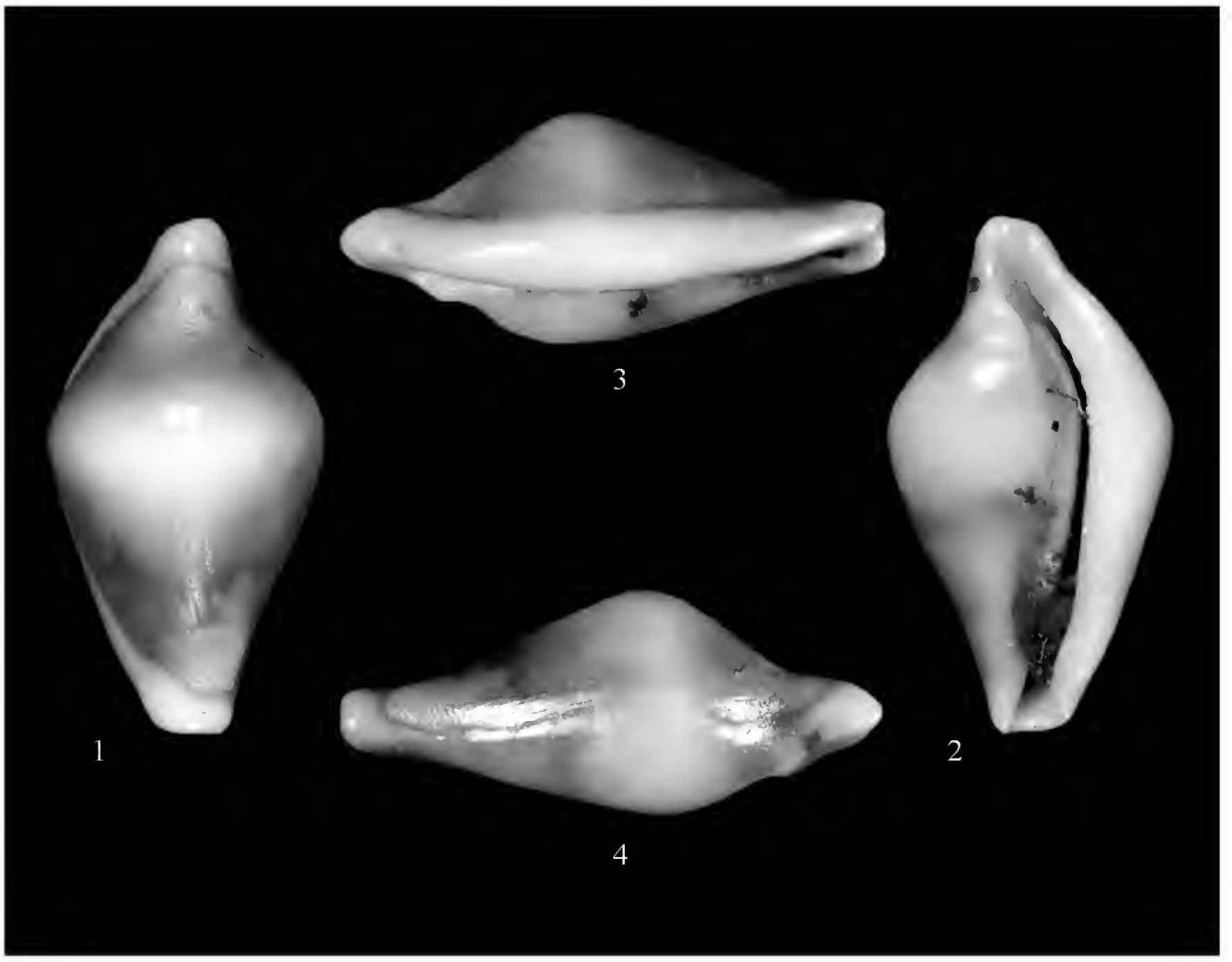
BIOLOGY. The Ovulidae is a family of carnivorous and ectoparasites molluscs, with a wide geographical distribution in tropical and temperate belt. The species *Xandarovula patula* (Pennant, 1777) is a northern one, reaching the latitude of England. The Ovulidae are host specific in the sense that the colour of the mollusc mantle, covering the shell, copies the host both in colour and geometry of the papillae as in the host polyps. They live on Anthozoa, and well known (Schiaparelli et al., 2005; Fehse, 2007) is the association, inside the Mediterranean, of *Neosimnia spelta* (Linnaeus, 1758) with *Eunicella cavolinii* (Koch, 1887) and *E. singularis* (Esper, 1791), and of *Simnia illyrica* Schilder, 1927 with *Leptogorgia sarmentosa* (Esper, 1791). More specimens of ovulid may live and predate on the same host, but this seems not to cause the death of the host.

Villogorgia bebrycoides has been reported at 70-130 m depth in the gulf of St. Eufemia (Calabria, South Tyrrhenian Sea) by Bo et al. (2012) and also in the Sicily channel, always in deep waters, therefore could occur in deep water at Punta Faro. In the rest of material found in the boat together with *A. juanjosensii* there were no pieces of *V. bebrycoides*, therefore the association with this gorgonians cannot be confirmed, at the same time there is the possibility that *A. juanjosensii* may live associated to any of the other gorgonians present in the sample. As above indicated, this multi-host preference has been reported by Schiaparelli et al. (2005) for *Neosimnia spelta*.

REMARKS. *A. juanjosensii* was described on five specimens (3 living, 2 dead) from Tenerife and La Palma islands. The species was found associated with the gorgonians *Villogorgia bebrycoides* (Koch, 1887) at a depth ranging from 100 to 250 m, catched with drag or shrimp net. Bouchet & Warén (1993: 746) report *A. juanjosensii* "on the seamounts between Madeira and Portugal in about 200-300 m". Oliverio & Villa (1998: 56) in the study on Ovulidae of the Canary islands figure a paratype (Figs. 13, 14) from Tenerife, but do not add anything to what known from previous literature.

Primovula (*Adamantia*) *bellocqae* Cardin, 1997 is described on four specimens trawled off the Atlantic coast of Marocco, between Safi and Agadir, at a depth of 50-60 m. Actually, the Author (Cardin, 1997) used the generic name "*bellocqae*" in the title and figure explanation, while in the text there is and additional "*u*" and the name is written "*bellocquae*". Similarly, also the name of the other species is wrongly written: "*juanjoseensis*" or "*juanjoneensis*". The Author states that the new species is very similar to *A. juanjosensii*, but due to the very schematic original drawing, a detailed description of the discriminant characters was not possible. Fehse (2003) put in synonymy the two names. The mediterranean records are few and the collecting locality are not detailed. One specimen 12 mm high, from Western Mediterranean, is figured by Ardovini & Cossignani (2004: 112) under the name *Primovula bellocque*. Two specimens, one from Marsala (Western Sicily) and one from Alboran are figured by Cossignani & Ardovini (2011: 234). Another specimen labelled from Trapani (West Sicily) is present in the collection of the Museo Malacologico of Cupra Marittima. The above records indicate a distribution in the Western Mediterranean, which is confirmed and extended up to the Eastern Sicily by our discovery.

The original description fails to indicate the marked dorsal gibbosity, well visible in lateral view. In addition the colour of our specimen clearly shows the two yellowish bands at the extremities, at the beginning of the callus, interconnected by a yellow band running behind the thickening of the outer lip. *A. juanjosensii* clearly differs from *A. adriatica* (Sowerby G. B. I, 1828) for the dorsal gibbosity, the angulated profile in frontal view, the elongated posterior extremity and the narrower aperture. The denticles on the external lip are present in both species. Same differences apply also to *Pseudosimnia carnea* (Poiret, 1789).



Figures 1-4. *Aperiovula juanjosensii* Pérez et Gómez, 1987, Punta Faro, Messina, Italy, -90 m, height 7.8 mm. Fig. 1: dorsal view. Fig. 2: ventral view. Figs. 3, 4: lateral view.

Additional note. When the work was ready for publication, a second specimen has been found in the same locality, by same fishing boat. The second specimen is 8.2 mm high and 4.2 mm wide, very fresh.

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REFERENCES

Ardovini R. & Cossignani T., 2004. Conchiglie dell'Africa occidentale (incluse Azzorre, Madeira e Canarie). L'Informatore Piceno, Ancona, 320 pp., 2180 figs.

Bo M., Canese S., Spaggiari C., Pusceddu A., Bertolino M., Angiolillo M., Giusti M., Loreto M. F., Salvati E., Greco S. & Bavestrello G., 2012. Deep Coral Oases in the South Tyrrhenian Sea. PLoS One (published via Internet), 7(11): e49870.

Bouchet P. & Warén A., 1993. Revision of the northeast Atlantic bathyal and abyssal Mesogastropoda. Bollettino Malacologico. Suplement 3: 579-840, 1953 figs.

Cardin C., 1997. *Primovula* (*Adamantia*) *bellocqae* n. sp. La Conchiglia, 29 (285): 24-25.

Cossignani T. & Ardovini R., 2011. Malacologia Mediterranea. L'Informatore Piceno, Ancona, 536 pp.

Fehse D., 2003. Beiträge zur kenntnis der Ovulidae. XIII. *Pseudosimnia flava*, spec. nov. und *Aperiovula juanjosensii* Pérez & Gómez, 1987 aus dem Bathyal des Zentralatlantiks (Mollusca, Gastropoda). Spixiana, 26: 269-275.

Fehse D., 2007. Contributions to the knowledge of the Ovulidae. XVI. The higher systematics. Spixiana, 30: 121-125.

Oliverio M. & Villa R., 1998. Notes on the Ovulidae of Canary Islands (Prosobranchia, Eratoidea). Argonauta, XI, 2: 49-58.

Pérez G. & Gómez R., 1987. *Aperiovula juanjosensii* spec. nov. (Mollusca Gastropoda): una nuova specie delle isole Canarie. Argonauta, III, 1-2 (13-14): 231-235.

Schiaparelli S., Barucca M., Olmo E., Boyer M. & Canapa A., 2005. Phylogenetic relationships within Ovulidae (Gastropoda: Cypraeoidea) based on molecular data from 16S rRNA gene. Marine Biology, 147: 411-420, figs. 1-2 + Suppl. (published via Internet): 1-22, text figs. 3-21.

Biodiversity Journal, 2013, 4 (3): 419-426

Contribution to the phenological knowledge of *Aspilota*-group (Hymenoptera Braconidae Alysiinae) in Mediterranean landscapes

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ABSTRACT This work analyses the phenology of *Aspilota*-group in three Mediterranean Natural parks: Natural Park of La Font Roja, Natural Park of Las Lagunas de la Mata-Torrevieja and Natural Park of La Tinença de Benifassà. Samples were carried out from April 2004 to December 2007. In total, 820 specimens of 53 different species were collected and analysed. The results showed that there was a direct relationship between phenology and climatic conditions, as the highest abundances of *Aspilota* Förster, 1862 were observed when temperatures were between 18-22ºC and a few weeks after the rainy season. Phenological information at species level is also provided.

KEY WORDS Hymenoptera; Braconidae; *Aspilota*-group; Phenology; Mediterranean; Natural parks; Spain.

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INTRODUCTION

Braconidae is the second largest family of Hymenoptera Apocrita, belonging to the superfamily Ichneumonoidea with approximately 40,000 species described around the World. The majority of these species are primary parasitoids of immature stages of Lepidoptera, Coleoptera and Diptera (Sharkey, 1993).

The subfamily Alysiinae has a prominent position in terms of diversity within the Braconidae (Dolphin & Quicke, 2001), enclosing 1,500 species divided among 2 tribes: Alysiini and Dacnusini (Shenefelt, 1974). Alysiini interact with a wide variety of Cyclorrhapha hosts mainly in humid habitats and ephemeral substrata, laying their eggs in the host's larvae or eggs. Dacnusini, by contrast, are almost exclusively specialised on leaf and stem miners, such as Agromyzidae, Ephydridae and Chloropidae. Furthermore, Alysiini are distributed in all regions while Dacnusini are known only in the temperate and boreal regions of the Northern Hemisphere.

The *Aspilota*-group is rather well differentiated inside the Alysiini tribe (van Achterberg, 1988) with approximately 750 species described (Yu et al., 2011). This group includes the following genera: *Adelphenaldis* Fischer, 2003, *Aspilota* Förster, 1862, *Carinthilota* Fischer, 1975, *Dinostigma* Fischer, 1966, *Dinotrema* Förster, 1862, *Eudinostigma* Tobias, 1986, *Leptotrema* van Achterberg, 1988, *Orthostigma* Ratzeburg, 1844, *Panerema* Förster 1862, *Pterusa* Fischer, 1958 and *Synaldis* Förster , 1862. However, this classification has been changing over the last decades. For instance, van Achterberg (1988) did not consider *Synaldis* as a genus and included their species within *Dinotrema* but Fischer (1993a;1993b), Belokobylskij (2002;

2004a; 2004b) and Tobias (2003a; 2003b; 2004a; 2004b; 2006) posteriorly published *Synaldis* as a distinctive genus due to the absence of the 2RS vein.

There are many faunal and diversity studies of Braconidae worldwide, for example in Brazil (Cirelli & Penteado-Dias, 2003; Scatolini & Penteado-Dias, 2003), Venezuela (Briceño et al., 2007; 2009) and the Iberian Peninsula (Andorra, Spain and Portugal), (Nieves & del Castillo, 1991; Pujade-Villar, 1996; Segade et al.,1997; Ros-Farré & Pujade-Villar, 1998; González et al., 2000; Martínez de Murguía et al., 2001; Tomé et al., 2001; Falcó-Garí et al., 2006). Nevertheless, the phenology of these species remains poorly investigated due to the lack of extensive monitoring studies. A few exceptions are Falcó-Garí et al. (2006), Peris-Felipo & Jiménez-Peydró (2011), Jiménez-Peydró & Peris-Felipo (2011) and Pérez-Rodríguez et al. (2013).The present study deals with data obtained from extensive researches on phenology and on the relationship between the *Aspilota*-group community and the environmental and climatic conditions present on three protected Mediterranean areas in Spain.

MATERIALS AND METHODS

Studied areas

The parks selected were Natural Park of La Font Roja (Font Roja), Natural Park of Las Lagunas de la Mata-Torrevieja (Torrevieja) and Natural Park of La Tinença de Benifassà (Tinença); all located within the Comunidad Valenciana and each with peculiar microclimate conditions. Climatic and orographic descriptions were given by Peris-Felipo & Jiménez-Peydró (2012).

Sampling protocol

The sampling period ranged from April 2004 to December 2007 and samples were taken with Malaise traps. Each area was weekly visited to be sampled with an entomological net and to replace the trap drop. Exemplars captured were preserved in 70% ethanol until final preparation.

Once separated, single specimens were determined by subfamily following the keys of Achterberg (1993) and only the Alysiinae were selected. Subsequently, the identification to genera was carried out according to Tobias keys (1986a; 1986b). Finally, species identification was done based on Fischer (1993b; 2003; 2008a; 2008b) and Tobias (1986a; 1986b) keys. The studied exemplars are now deposited with bar code labels in the Entomological Collection at the University of Valencia (Valencia, Spain; ENV).

Information about all climatic conditions was provided by AEMET (State agency of Metereology) with the exception of the one from Font Roja. Data about this area was taken from Bocairent station, as there is no AEMET station in Alcoi.

In the present study, the following simplifications of period extensions were adopted:

- Spring: period comprising between 23rd March and 22nd June.
- Summer: period comprising between 23rd June and 22nd September.
- Autumn: period comprising between 23rd September and 22nd December.
- Winter: period comprising between 23rd December and 22nd March.

RESULTS AND DISCUSSION

In total, 820 specimens belonging to 53 species of *Aspilota*-group were collected. The Natural Park with more described species was Tinença with 39, followed by Font Roja and Torrevieja with 23 and 21, respectively. Furthermore, the number of captures differed between areas, having collected 383 individuals in Tinença (49.08%), 257 in Torrevieja (63.03%) and 182 in Font Roja (65.93%). The most captured species in Font Roja was *Orthostigma laticeps* (Thomson, 1895) followed by *Synaldis lacessiva* Fischer, 1975 and *Dinotrema parapunctatum* (Fischer, 1976). However, *Dinotrema costulatum* (Thomson, 1895) was the most represented in Tinença, followed by *Synaldis* sp.2, *Dinotrema crassicostum* (Thomson, 1895), *Aspilota valenciensis* Fischer, 1996 and *Dinotrema castaneithorax* (Fischer, 1973). Finally, *Synaldis* sp.2, *Dinotrema lagunasense* Peris-Felipo, 2013 and *Aspilota procreata* Fischer, 1976 were the most dominant in Torrevieja.

The whole data (Fig. 1) showed that species belonging to *Aspilota*-group can be found throughout

the entire year.The highest abundance was found between April and September (spring and summer), identifying two peaks corresponding to spring-summer (March-July) and autumn (September-November).

The analysis of the Natural Park of La Font Roja (Fig. 2) demonstrated that there were quite more capture peaks. The activity period at this area was extended from April till late September (spring and summer), peaking at the end of May and with a lack of captures between December and April (winter and early spring).

However, Natural Park of La Tinença of Benifassà (Fig. 3) showed a different situation with two peaks of activity, the first between April and June (spring) and the second between September and November (autumn). The highest abundances were observed in May and June 2006, both with 18 specimens. Captures in the remaining months were very sporadic, being virtually absent during the winter.

Finally, two peaks of activity were determined in the Natural Park of Las Lagunas de La Mata-Torrevieja (Fig. 4), one between April and June (spring) and the other between October and December (autumn). The highest abundance was observed on April 2005 with 19 specimens and a third peak was observed in some years between December and March (winter). However, no specimens were ever captured between late July and early September.

The analysis of abundance (Figs. 2-4) clearly shows that the peaks appear at different periods on each site. Comparison between these peaks and climatic data (temperature and rainfall) was done by superimposing the first to the second.

It is possible to observe that in Font Roja (Fig. 5) the largest number of captures occurs between June and September after the spring rainfall and coinciding with temperate temperatures (15-25°C). By contrast, there are no significative captures during autumn and winter.

However, in Tinença (Fig. 6) the maximum peaks of abundance occur a few weeks after the rainy season and *Aspilota* populations seem to decrease till disappearing when temperatures exceed 20ºC (July-August). Therefore, the population seems to be affected by the presence and abundance of rainfall, probably due to their parasitoid relationship with leaf-miner insects, mainly from herbaceous.

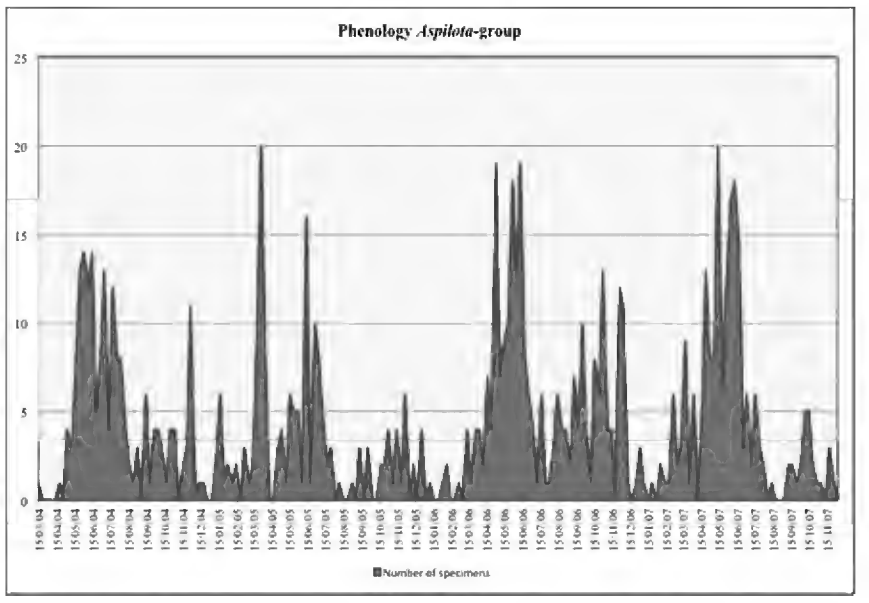
In Torrevieja (Fig. 7) braconids are better captured when temperatures are temperate (15-20°C) and they disappear when temperatures rise.

All these considered, it is possible to check the relationships between the appearance of *Aspilota*-group and rain. Table 1 shows the phenology of each species per month, with most of the species being present in spring. However, there are species that appear in spring and autumn but not in warm periods such as *Aspilota procreata* Fischer, 1976, *Dinotrema enanum* Peris-Felipo, 2013, *Dinotrema fischerianum* Peris-Felipo, 2013, *Synaldis concolor* (Nees, 1812) and *Synaldis distractum* (Nees, 1834). Some other species appear during autumn and winter, e.g., *Dinotrema lagunasense* Peris-Felipo, 2013, *Dinotrema pareum* Peris-Felipo, 2013 and *Synaldis* sp.7 and many others appear in every season, such as *Aspilota propeminimam* Fischer, Tormos, Pardo et Asís, 2008, *Aspilota valenciensis* Fischer, 1996, *Dinotrema costulatum* (Thomson, 1895), *Dinotrema paquitae* Peris-Felipo, 2013, *Orthostigma laticeps* (Thomson, 1895), *Orthostigma maculipes* (Haliday, 1838), *Orthostigma pumilum* (Nees, 1834) or *Synaldis* sp.2. Finally, three species: *Dinotrema teresae* Peris-Felipo, 2013, *Orthostigma beyarslani* Fischer, 1995 and *Orthostigma sculpturatum* (Tobias, 1962), seem to be present only for a month.

Comparing the three different parks, it is possible to determine that the maximum peaks of abundance occur when temperature ranges oscillate between 18 and 22ºC. Similar observations were found in the Artikutza (Navarra, Spain) when studying the phenology of Alysiinae (Peris-Felipo et al., 2011) and in the Andorran Pyrenees (Falcó-Garí et al., 2006) while analyzing the Braconidae. Another fact to be highlighted is that maximum abundances are always present few weeks after the rainy periods. This is probably explained by tritrophic relationships between parasitoid-host-plant, as the rain promotes the growth of herbaceous whose leaves are mined by mining insects and consequently increases the activity of the Hymenoptera parasitoids.

In conclusion, this study was conducted to determine the phenology of the *Aspilota*-group. However, further studies are recommended in different areas to check the differences between *Aspilota* behaviors.

1



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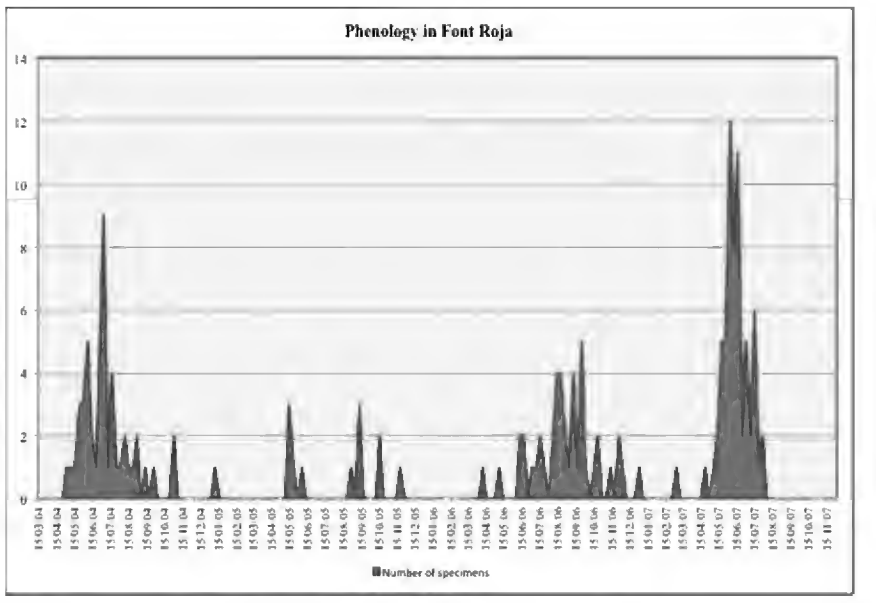

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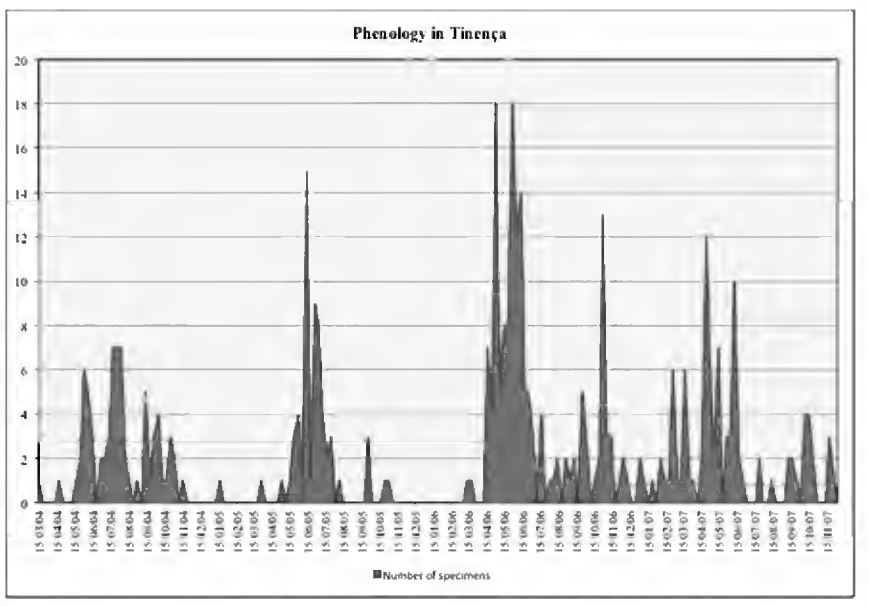

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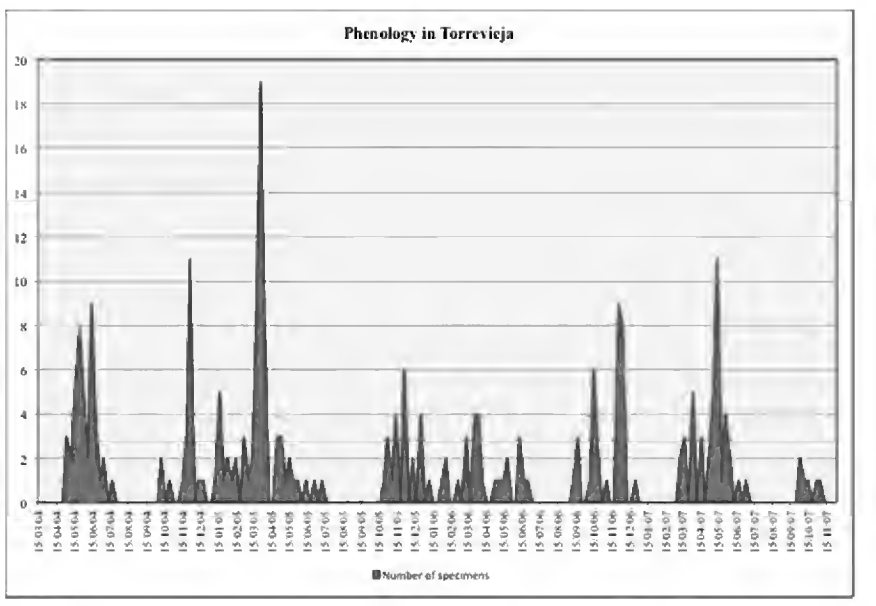

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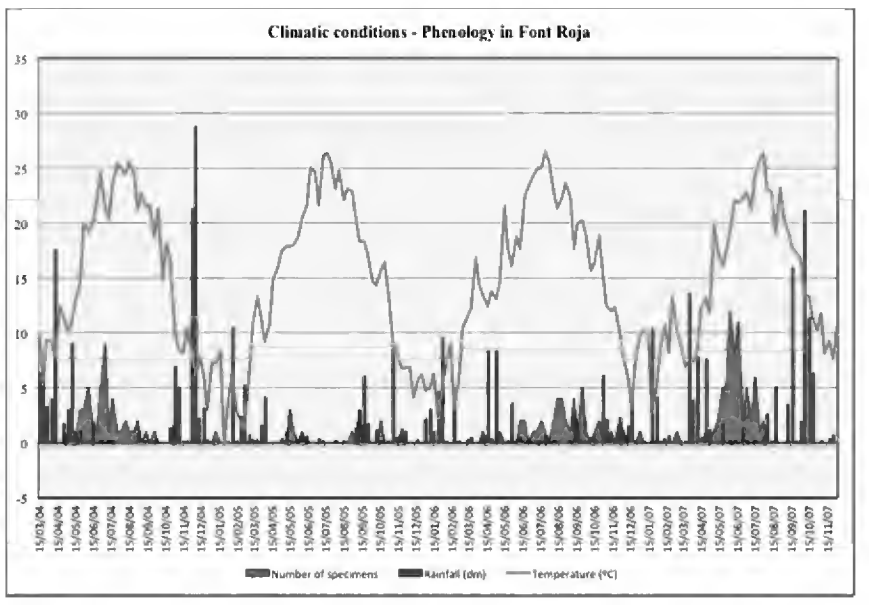

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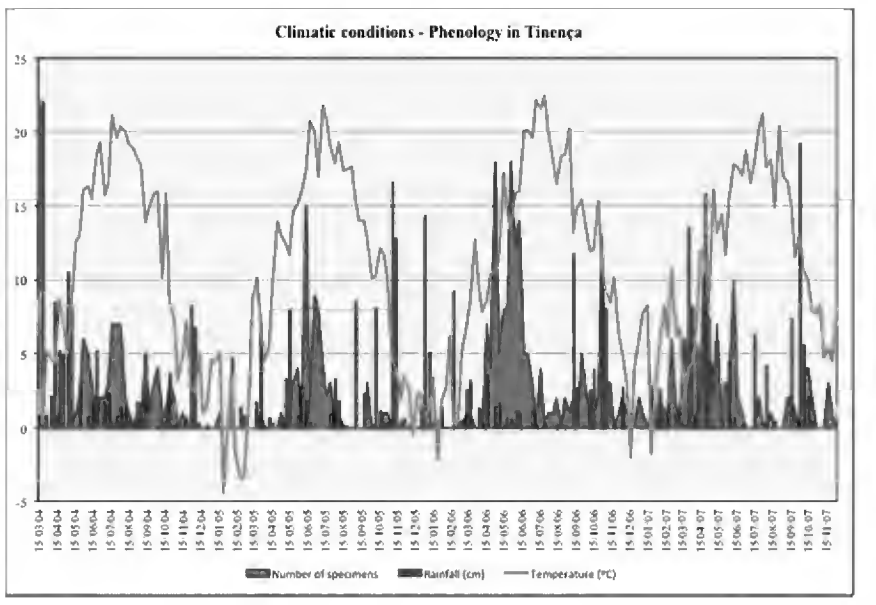

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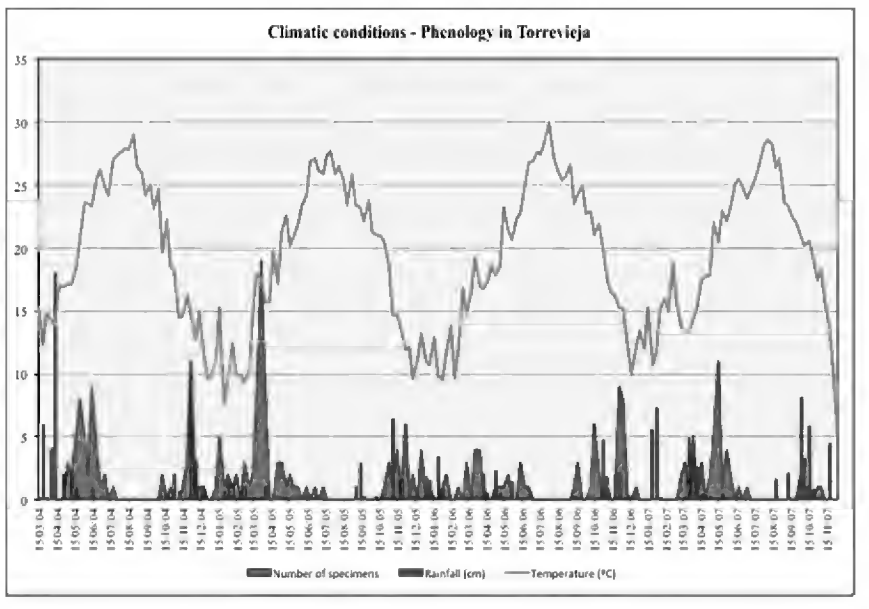

Figure 1. Phenology of *Aspilota*-group.
Figure 2. Phenology of *Aspilota*-group in the Natural Park of Carrascal de La Font Roja.
Figure 3. Phenology of *Aspilota*-group in the Natural Park of Tinença de Benifassà.
Figure 4. Phenology of *Aspilota*-group in the Natural Park of las Lagunas de La Mata-Torrevieja.
Figure 5. Relationship between climatic conditions and phenology in the Natural Park of La Font Roja.
Figure 6. Relationship between climatic conditions and phenology in the Natural Park of La Tinença de Benifassà.
Figure 7. Relationship between climatic conditions and phenology in the Natural Park of Las Lagunas de La Mata-Torrevieja.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adelphenaldis maxfischeri						■	■					
Aspilota anaphoretica					■					■		
Aspilota delicata			■						■			
Aspilota flagimilis						■					■	
Aspilota insolita			■			■						
Aspilota procreata			■	■	■	■						■
Aspilota propedaemon			■		■	■		■				■
Aspilota propeminimam		■	■	■	■	■	■				■	
Aspilota valenciensis	■		■	■	■	■		■		■		
Aspilota sp1					■	■						
Aspilota sp2				■		■						
Dinotrema achterbergi		■				■				■	■	■
Dinotrema amparoae		■	■	■							■	
Dinotrema belokobylskiji										■		
Dinotrema benifassaense				■	■	■	■					
Dinotrema broadi	■	■			■		■			■	■	
Dinotrema castaneithorax		■		■	■	■		■	■	■		
Dinotrema costulatum	■	■	■	■	■	■	■		■	■	■	
Dinotrema crassicostum				■	■	■		■	■	■		
Dinotrema enanum				■	■							■
Dinotrema fischerianum				■	■							
Dinotrema jimenezi									■	■		
Dinotrema lagunasense	■	■	■	■							■	■
Dinotrema mareum					■		■					
Dinotrema munki					■					■		
Dinotrema pappi	■				■							
Dinotrema paquitae		■	■	■	■		■			■		
Dinotrema parapunctatum						■	■	■	■	■		
Dinotrema pareum	■	■	■	■						■	■	
Dinotrema pilarae	■											
Dinotrema robertoi							■	■	■			
Dinotrema teresae				■								
Dinotrema tinencaense						■	■	■				
Dinotrema torreviejaense				■	■							
Dinotrema vitobiasi				■	■							
Dinotrema zimmermannae				■		■	■			■	■	
Eudinostigma latistigma					■	■	■					
Orthostigma beyarslani					■							

Table 1. Monthly occurrence for each species.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Orthostigma laticeps	■		■	■	■	■	■	■	■	■		■
Orthostigma maculipes			■		■	■	■		■			
Orthostigma pumilum			■		■	■	■	■	■	■		
Orthostigma sculpturatum								■				
Synaldis concolor	■	■	■	■	■	■	■					
Synaldis distracta	■	■	■	■	■	■	■				■	
Synaldis lacessiva					■	■	■	■	■	■	■	
Synaldis sp1							■					
Synaldis sp2	■			■	■	■	■	■	■	■	■	■
Synaldis sp3							■				■	
Synaldis sp4						■	■	■	■	■		
Synaldis sp5		■			■	■	■					
Synaldis sp6					■	■			■	■		
Synaldis sp7		■	■									

Table 1 (continued). Monthly occurrence for each species.

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REFERENCES

Achterberg C. Van, 1988. The genera of the *Aspilota*-group and some descriptions of fungicolous Alysiini from the Netherlands (Hymenoptera: Braconidae: Alysiinae). Zoologische Verhandelingen Leiden, 247:1-88.

Achterberg C. Van, 1993. Illustrated key to the subfamilies of Braconidae (Hymenoptera: Ichneumonoidea). Zoologische Verhandeligen Leiden, 283: 1-189.

Belokobylskij S.A., 2002. Eastern Palaearctic Species of the Braconid Wasp Genus *Synaldis* Förster (Hymenoptera, Braconidae, Alysiinae). Species without mesoscutal pit. Entomological Review, 82: 404-423.

Belokobylskij S.A., 2004a. Eastern Palaearctic Species of the Braconid Wasp Genus *Synaldis* Förster (Hymenoptera, Braconidae, Alysiinae). Species with mesoscutal pit: I. Entomological Review, 84: 191-215.

Belokobylskij S.A., 2004b. Eastern Palaearctic Species of the Braconid Wasp Genus *Synaldis* Förster (Hymenoptera, Braconidae, Alysiinae). Species with mesoscutal pit: I. Entomological Review, 84: 935-945.

Briceño R., Torres P. & Romero L., 2007. Composición faunística y distribución de la familia Braconidae (Hymenoptera: Ichneumonoidea) en tres ecosistemas naturales de Venezuela. Folia Entomológica Mexicana, 6: 1413-1418.

Briceño R., Torres D. & Zaldívar-Riveron A., 2009. Primer reporte de la familia Braconidae (Hymenoptera: Ichneumonoidea) en los parques Cerro Sarroche y Terepaima, Estado Lara, Venezuela. Bioagro, 21: 223-226.

Cirelli K.R.N. & Penteado-Dias A.M., 2003. Fenologia dos Braconidae (Hymenoptera: Ichneumonoidea) da Área de Proteçao Ambiental (APA) de Descalvado, SP. Revista Brasileira de Entomologia, 47: 99-105.

Dolphin K. & Quicke D.L.J., 2001. Estimating the global species richness of an incompletely described taxon: an example using parasitoid wasps (Hymenoptera: Braconidae). Biological Journal of the Linnean Society, 73: 279-286.

Falcó-Garí J.V., Oltra-Moscardó M.T., Moreno-Marí J., Pujade-Villar J.& Jiménez-Peydró R., 2006.

Fenología de los bracónidos (Hymenoptera, Braconidae) del Pirineo andorrano. Pirineos, 161: 111-132.

Fischer M., 1993a. Zur Formenvielfalt der Kieferwespen der Alten Welt: Über die Gattungen *Synaldis* Foerster, *Trisynaldis* Fischer und *Kritscherysia* Fischer gen. nov. (Hymenoptera, Braconidae, Alysiinae). Annalen des Naturhistorischen Museums in Wien, 94-95(B): 451-490.

Fischer M., 1993b. Eine neue Studie über Buckelfliegen-Kieferwespen: *Synaldis* Foerster und *Dinotrema* Foerster (Hymenoptera, Braconidae, Alysiinae). Linzer Biologische Beitraege, 25: 565-592.

Fischer M., 2003. Ein Beitrag zur Kenntnis der Gattungen *Synaldis* Foerster und *Adelphenaldis* Fischer, gen. nov. (Hymenoptera, Braconidae, Alsyinae). Linzer Biologische Beitraege, 35: 19-74.

Fischer M., Tormos J., Pardo X. & Asis J.D., 2008a. New citations of Alysiini from Spain, with a description of *Dinotrema mediocornis hispanicum* nov. ssp. and of the females of *Aspilota inflatinervis* and *Synaldis azorica* (Hymenoptera, Braconidae, Alysiinae). Linzer Biologische Beitraege, 40: 1449-1466.

Fischer M., Tormos, J., Pardo, X. & Asis J.D., 2008b. Descriptions of adults, preimaginal phases, and venom apparatus of a new species of *Aspilota* Förster from Spain (Hymenoptera, Braconidae). Zoological Studies, 47: 247-257.

González J.A., Tomé M.A.M., Gayubo S.F. & Torres F., 2000. Himenópteros aculeados capturados mediante trampas Malaise en un sector arenoso de la Submeseta Norte (España) (Hymenoptera, Aculeata). Nouvelle revue d'Entomologie, 17: 337-353.

Jiménez–Peydró R. & Peris-Felipo F.J., 2011. Diversity and community structure of Opiinae (Hymenoptera: Braconidae) in the forest estate of Artikutza (Spain). Florida Entomologist, 94: 472-479.

Martínez de Murguía L., Vázquez M.A. & Nieves-Aldrey J.L., 2001. The families of Hymenoptera (Insecta) in an heterogeneous acidofilous forest in Artikutza (Navarra, Spain). Frustula Entomologica, 24: 81-98.

Nieves-Aldrey J.L. & Rey del Castillo C., 1991. Ensayo preliminar sobre la captura de insectos por medio de una trampa Malaise en la Sierra de Guadarrama (España) con especial referencia a los himenópteros (Insecta, Hymenoptera). Ecología, 5: 383-403.

Pérez-Rodríguez J., Oltra-Moscardó T., Peris-Felipo F.J. & Jiménez-Peydró R., 2013. Microgastinae (Hymenoptera: Braconidae) in the Forest State of Artikutza (Navarra: Spain): Diversity and Community Structure. Insects, 4: 493-505; doi:10.3390/insects4030493.

Peris-Felipo F.J. & Jiménez-Peydró R., 2011. Biodiversity within the subfamily Alyssinae (Hymenoptera, Braconidae) in the Natural Park Peñas de Aya (Spain). Revista Brasileira de Entomologia, 55: 406-410.

Peris-Felipo F.J. & Jiménez-Peydró R., 2012. Cerambycidae (Coleoptera) richness in Mediterranean landscapes of Spain: diversity and community structure analysis. BiodiversityJournal, 3: 59-68.

Pujade-Villar J. 1996. Resultados preliminares obtenidos a partir de una trampa Malaise situada en una zona mediterránea pirenaica. Pirineos, 147-148: 61-80.

Ros-Farré P. & Pujade-Villar J., 1998. Estudio mediante una trampa Malaise de la comunidad de cinípidos cecidógenos e inquilinos de Santa Coloma, Andorra (Hymenoptera, Cynipidae). Ecología, 12: 441-454.

Scatolini D. & Penteado-Dias A.M., 2003. Análise faunística de Braconidae (Hymenoptera) emtrês áreas de mata nativa do Paraná, Brasil. Revista Brasileira de Entomologia, 47: 187-195.

Segade C., Ros-Farré P., Algarra A., Ventura D. & Pujade-Villar P., 1997. Estudio comparativo de las capturas realizadas con trampa Malaise en Andorra con especial atención a los himenópteros (Hymenoptera). Zapateri (Revista Aragonesa de Entomología), 7: 71-82.

Sharkey M.J., 1993. Family Braconidae. In: Goulet H. & Huber J.T. (Ed.), Hymenoptera of the World: An Identification Guide to Families. Canada, Agriculture Canada, pp. 362-395.

Shenefelt R.D.,1974. Pars 11. Braconidae 7. Alysiinae. In: Van der Vecht J. & Shenefelt R.D. (Eds.), Hymenopterorum Catalogus (nova edition). Dr. W. Junk. B. V. The Hague, Junk, pp. 937-1113.

Tobias V.I., Belokobylskij S.A. & Kotenko A.G., 1986a. Family Braconidae. In: Medvedev G.S. (Ed.), Keys to the Insects of the European Part of the USSR, III. Part IV. Leningrad, Nauca Publisher, 500 pp.

Tobias V.I., Jakimavicius A.B. & Kiriyak I.G., 1986b. Family Braconidae. In: Medvedev G.S. (Ed.), Keys to the Insects of the European Part of the USSR, III.Part V. Leningrad, Nauca Publisher, 507 pp.

Tobias V.I., 2003a. Species of the Genus *Dinotrema* Foerster, 1862 (Hymenoptera, Braconidae, Alysiinae) without prescutellar pit and with smooth or only medially sculptured propodeum from Russia and Adjacent Territories. Entomological Review, 83: 279-294.

Tobias V.I., 2003b. Contribution to the knowledge of the Subgenus *Prosapha* stat. n. of the Genus *Dinotrema* (Hymenoptera, Braconidae, Alysiinae). Entomological Review, 83: 606-611.

Tobias V.I., 2004a. Species of the Genus *Dinotrema* Foerster, 1862 (Hymenoptera, Braconidae, Alysiinae) without prescutellar pit and with a widely sculptured propodeum and short mandibles from Russia and neighboring Territories. Entomological Review, 84: 216-232.

Tobias V.I., 2004b. Two new species of the Genus *Dinotrema* Foerster (Hymenoptera, Braconidae,

Alysiinae) without prescutellar pit. Entomological Review, 84: 673-676.

Tobias V.I., 2006. Palaeartic species of the Genus *Dinotrema* Foerster (Hymenoptera, Braconidae, Alysiinae) with a prescutellar pit and with long ovipositor. Entomological Review, 86: 324-336.

Tomé M.A.M., González J.A., Gayubo S.F. & Torres F., 2001. Estudio comparativo sobre la eficiencia de captura de insectos (Arthropoda, Hexapoda) mediante trampas Malaise, en un biotopo arenoso de la submeseta Norte (España). Boletín de la Real Sociedad Española de Historia Natural, Sección Biológica, 96: 231-241.

Yu D. S., Achterberg C. Van & Horstmann K., 2011. World Ichneumonoidea 2011. Taxonomy, biology, morphology and distribution. CD/DVD. Taxapad, Vancouver, Canada.

Biodiversity Journal, 2013, 4 (3): 427-434

Traditional agroforestry practices and woody species conservation in the derived savanna ecosystem of Adamawa state, Nigeria

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ABSTRACT Agroforestry practices are known to contribute to food security, environmental protection and biodiversity conservation. To determine the extent of contribution of some traditional agroforestry practices to woody species conservation, data were collected from the natural fallow land, grazing land and natural forest in and around the Gumti sector of Gashaka-Gumti National Park, covering Toungo and Jada local government areas of Adamawa State, Nigeria. The area was sampled in a group of twelve 0.04 ha (20 m × 20 m) plots per land use type. All woody plants with diameter at breast height greater than or equal to 5 cm were identified. A total of 0.48 ha of natural fallow, grazing land and natural forest were surveyed. 361 individuals belonging to 27 taxa and 16 families were identified in the 0.48 ha of natural forest surveyed. In the natural fallow, 314 individuals belonging to 32 taxa in 16 families were encountered while the grazing land had 211 individuals belonging to 23 taxa in 16 families. The natural forest had the highest density of woody species (752.08 plants/ha) while the lowest (439.58 plants/ha) was observed on the grazing land. The values of Shannon diversity index differ significantly among the land use types with the natural forest having the highest (0.85), while the grazing land the least (0.56). The rarefaction curves, however, indicated that the grazing land had the highest species richness relative to the total number of individuals encountered.

KEY WORDS Agroforestry; natural fallow; forest; grazing land; woody species conservation.

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INTRODUCTION

Among the major challenges facing the world today are deforestation, land degradation, unsustainable farming practices, loss of biodiversity, increased risks of climate change and rising hunger, poverty and malnutrition. Agroforestry has been identified as a land-use option that can address many of these global challenges. Deliberate inclusion of trees in agricultural landscapes has been a common practice among farmers for a very long time and the farming communities have played important roles in conserving crop and tree diversity.

Although the traditional agroforestry practices have contributed immensely to food security and environmental protection, the need to meet the increasing needs of the burgeoning population has led to the development of modern agroforestry practices with simplified ecosystem structure and consequent destruction of biological diversity. In recent times, scientists have become interested in the environmental services that agroforestry practices

may provide to local and even global society by maintaining watershed functions, retaining carbon in the plant-soil system, and by supporting the conservation of biological diversity (McNeely & Scherr, 2003; Schroth et al., 2004). Greater attention is now being paid to those complex tree-based traditional practices that are so widespread in traditional tropical land use.

The natural environment in the savanna ecosystem is characterized by a combination of trees and grasses in different proportions. Farmers in the West African savannas maintain valuable trees, which also resist periodical fires in and around their fields giving rise to distinct park like landscape (Boffa, 1999). Scattered trees on farmland/pasture and bush fallowing are the common traditional agroforestry practices in the savanna ecosystem of Nigeria (Oboho & Anyia, 1992; Chup, 2004). Traditionally farmers grow crops under scattered trees of different species and they sometimes incorporate animal production with no special technique, species type or density per unit area. The trees are allowed to grow and they appear scattered over the farm. Many farmers in these areas also practice shifting cultivation which is the alternation of cropping periods with those of fallow.

Agroforestry systems in areas surrounding protected areas can reduce biodiversity loss, restore degraded areas, and integrate local cultural practices and economic needs into biodiversity conservation (Nair et al., 2005; Mcneely & Schroth, 2006; Ashley et al., 2006; Bhagwat et al., 2008). Many agroforestry systems have been studied for their roles in biodiversity conservation. There have been reports on biodiversity conservation in shade coffee agroforestry system (Perfecto et al., 1996; Moguel & Toledo, 1999), multistrata cocoa agroforestry (Oke & Odebiyi, 2007; Harvey & Gonzalez-Villalobos, 2007) and homegarden agroforests (Ewel, 1999). In a survey of floristic diversity of 402 home gardens from six regions across southwestern Bangladesh, Kabir & Webb (2009) reported 419 species including six species of conservation concern.

A study conducted by Backes (2001) on the contribution of agroforestry land use to the in-situ conservation of indigenous trees within a typical East African smallholder farming system in western Kenya shows how species diversity is ultimately linked to the loss of habitat diversity and landscape diversity. Fifanou et al. (2011) recorded twenty-one tree species belonging to 14 botanical families during the survey of traditional agroforestry parkland systems around the Pendjari Biosphere Reserve in Benin.

The present study seeks to evaluate the conservation values of the major traditional agroforestry practices in a derived savanna ecosystem of Nigeria.

MATERIALS AND METHODS

Study site

The study was carried out in and around Gumti sector, in the northern half of Gashaka-Gumti National Park, covering Toungo and Jada local government areas of Adamawa State. Gashaka-Gumti National Park (GGNP) is located on latitude 6°55′-8°13′N and longitude 11°13′-12°25′E. The Park is made up of the Gashaka sector in the southern half of the park, and Gumti sector in the Northern half. The Northern sector of the Gashaka-Gumti National Park consists of derived Savannah with forest fringing along streams, steep valleys and on mountain line. The rugged terrain is characterized by steep, thickly forested slopes, deep plunging valleys, precipitous escarpments and swiftly flowing rivers. Altitude is about 450 meters above sea level.

The area receives an annual rainfall of 1000-1200 mm. Rainfall distribution is unimodal, with much of the rain falling between April and November. Day time temperatures may drop below 18°C at higher altitudes and gradually rise to 40°C. The rainy season is followed by a dry season. During this period, the area comes under the strong influence of the hammattan (November and March), a dry dusty wind blowing from Sahara Desert, and temperatures may be significantly cooler (GGNP, 2010).

Experimental Design

Three land use types - undisturbed natural forest, grazing land, and abandoned natural fallow - were identified around the Gumti side of the park. Three transect lines were cut through the natural forest and grazing land at a minimum distance of 100 m apart. Four sampling plots of 20 m × 20 m in size were laid in alternate pattern along each transect at 50 m intervals. Four abandoned fallow (8-10 years of natural fallow) were selected from the encroa-

ched area very close to the Forest Reserve. Three 20 m x 20 m plot was demarcated within the centre of each fallow land and data were collected from each plot. Assessment of tree diversity was done in sample plots demarcated within each land use type and also on 20 m × 20 m demarcated within four natural fallow lands in the fringe settlements

With the assistance of an experienced taxonomist, all woody species (diameter at breast height, dbh ≥ 5 cm) encountered in each of the demarcated sample plots were identified and their frequency of occurrence recorded. For unknown tree species, leaves, slash and bark of such trees were collected and taken to the herbarium for identification. The total number of each tree species encountered in the twelve sample plots (0.48 ha) for each ecosystem was calculated (frequency) and the figure was used in estimating number of trees per hectare (tree density). Species diversity was calculated as $H' = -\sum\{(n_i/N)\log_e(n_i/N)\}$, where H' = Shannon index of general diversity, n_i = number of individuals of a species, N = total number of individuals in the community.

Data Analysis

Values of Shannon diversity indices and tree density of the three types of plant communities were compared using ANOVA. The rarefaction method (Gotelli & Colwell, 2001) was used to generate the expected number of species in natural fallow, grazing land and natural forest. The free software EstimateS 8.0 (Gotelli, 2006) was used to generate data for the construction of sample-based rarefaction curves and confidence intervals for species richness after re-scaling the x-axis to individuals.

RESULTS

Three hundred and sixty one individuals belonging to 27 taxa and 16 families were identified in the 0.48 ha of natural forest surveyed (Table 1). The richest families were Fabaceae and Combretaceae which had five species each. Families Rubiaceae, Euphorbiaceae and Caeselpiniaceae had two species each. The predominant 10 woody species present in the natural forest accounted for 85% of total population. They included *Detarium microcarpum*, *Lophira lanceolata*, *Hymenocardia acida*, *Crossopteryx febrifuga*, *Burkea africana*, *Bridelia ferruginea*, *Terminalia glaucescens*, *Prosopis africana*, *Annona senegalensis* and *Daniella oliveri*.

In the 0.48 ha of the natural fallow surveyed, 314 individuals belonging to 32 species in 16 families were encountered (Table 2). The richest families were Fabaceae (ten species) and Combretaceae (six species). The dominant woody species were *Philiostigma thonningii*, *Acacia gourmaensis*, *Anogeissus leiocarpus*, *Pteleopsis habeensis*, *Strychnos innocua*, *Combretum molle*, *Boswellia dalzielii* and *Dichrostachys cinerea*. In the 0.48 ha of the grazing land surveyed, 211 individuals belonging to 23 taxa in 16 families were encountered (Table 3). The richest family was Combretaceae which had five species. Family Meliaceae had three species, Fabaceae two species. The dominant woody species were *Anogeissus leiocarpus*, *Philiostigma thonningii*, *Combretum molle*, and *Vitellaria paradoxa*.

The natural forest had the highest density of woody species (752.08 plants/ha) while the lowest (439.58 plants/ha) was observed on the grazing land. Woody species diversity was also significantly higher in the natural forest indicating a greater variety of species (Table 4). The rarefaction curves (Fig. 1) also indicate that the natural forest supports a species richness relatively higher than floristically and climatically similar sites of grazing land and natural fallow.

DISCUSSION

This study reveals that a large number of woody species occur in the traditional bush fallow system and scattered trees on grazing land systems of the derived guinea savanna ecosystem of Adamawa State, Nigeria. However a modification of the species composition was observed in both the grazing land and natural fallow with more pioneer species and different dominant species compared with the natural forest. *Anogeissus leiocarpus* and *Philiostigma thonningii* were the dominant woody species in both the natural fallow and the grazing land systems as opposed to *Detarium microcarpum* which dominated the natural forest. The dominance of *Anogeissus leiocarpus* in the natural fallow and the grazing land systems may not be unconnected with its attribute as a pioneer species which grows well in open forest clearings. Moreover, farmers might have deliberately retained the species because of its

SPECIES	FAMILY	FREQUENCY	DENSITY (TREES/HA)
Detarium microcarpum Guill et Sperr	Caeselpiniaceae	87	181.25
Lophira lanceolata Tiegh. ex Keay	Ochnaceae	43	89.58
Hymenocardia acida Tul.	Euphorbiaceae	37	77.08
Crossopteryx febrifuga (Afzel. ex G.Don) Benth.	Rubiaceae	34	70.83
Burkea africana Hook.	Caeselpiniaceae	29	60.42
Bridelia ferruginea Benth.	Euphorbiaceae	23	47.92
Terminalia glaucescens Planch. ex Benth.	Combretaceae	20	41.67
Prosopis africana (Guill. et Perr.) Taub. 1893	Fabaceae	15	31.25
Annona senegalensis Pers.	Annonaceae	10	20.83
Daniella oliveri (Rolfe) Hutch et Dalziel	Fabaceae	9	18.75
Parinari excelsa Sabine	Chrysobalanaceae	7	14.58
Piliostigma thonningii (Schumach.) Milne-Redh.	Fabaceae	7	14.58
Maytenus senegalensis (Lam.) Exell	Celastraceae	6	12.50
Lannea acida A. Rich.	Anacardiaceae	5	10.42
Anogeissus leiocarpa (DC.) Guill. et Perr.	Combretaceae	4	8.33
Ficus sp.	Moraceae	4	8.33
Entada africana Guill. et Perr.	Fabaceae	3	6.25
Pericopsis laxiflora (Benth.) Meeuwen	Papilionaceae	2	4.17
Securidaca longipedunculata Fresen.	Polygalaceae	2	4.17
Bombax costatum Pellegr. et Vuill.	Malvaceae	1	2.08
Boswellia dalzielii Hutch.	Burseraceae	1	2.08
Combretum gabonense Exell	Combretaceae	1	2.08
Combretum glutinosum Perr. ex DC.	Combretaceae	1	2.08
Combretum sp.	Combretaceae	1	2.08
Nauclea latifolia Smith	Rubiaceae	1	2.08
Pterocarpus erinaceus Poir.	Fabaceae	1	2.08
Vitex simplicifolia Oliv.	Verbanaceae	1	2.08
		361	

Table 1. Diversity of tree/shrub species in the 0.48 ha of Natural forest in the derived savanna ecosystem of Adamawa State.

SPECIES	FAMILY	FREQUENCY	DENSITY (TREES/HA)
Philiostigma thonningii (Schum.) Milne-Redh	Fabaceae	81	168.75
Anogeissus leiocarpus (DC.) Guill. et Peer.	Combretaceae	57	118.75
Acacia gourmaensis A. Chev.	Fabaceae	27	56.25
Pteleopsis habeensis Aubrev. ex Keay	Combretaceae	19	39.58
Strychnos innocua Delile	Loganiaceae	17	35.42
Combretum molle R.Br. ex G.Don	Combretaceae	15	31.25
Boswellia dalzielii Hutch.	Burseraceae	12	25.00
Dichrostachys cinerea (L.) Wight et Arn.	Mimosaceae	12	25.00
Annona senegalensis Pers.	Annonaceae	7	14.58
Acacia nilotica (L.) Willd. ex Delile	Fabaceae	6	12.50
Combretum glutinosum Perr. ex DC.	Combretaceae	6	12.50
Ziziphus mauritiana Lam.	Rhamnaceae	6	12.50
Acacia sp.	Fabaceae	5	10.42
Daniella oliveri (Rolfe) Hutch et Dalziel	Fabaceae	5	10.42
Diospyros spp	Ebenaceae	5	10.42
Entada africana Guill et Perr.	Fabaceae	5	10.42
Acacia ataxacantha DC.	Fabaceae	4	8.33
Combretum gabonense Exell	Combretaceae	4	8.33
Combretum sp.	Combretaceae	3	6.25
Gmelina arborea Roxb. ex Sm.	Lamiaceae	3	6.25
Vitellaria paradoxa C.F.Gaertn.	Sapotaceae	3	6.25
Isoberlinia doka Craib et Stapf.	Fabaceae	2	4.17
Acacia polyacantha Willd.	Fabaceae	1	2.08
Bombax costatum Pellegr. et Vuill.	Malvaceae	1	2.08
Crossopteryx febrifuga (Afzel. ex G. Don)	Rubiaceae	1	2.08
Detarium microcarpum Guill et Sperr	Caeselpiniaceae	1	2.08
Hymenocardia acida Tul.	Phyllanthaceae	1	2.08
Lannea schimperi (Hochst. ex A. Rich.) Engl.	Anacardiaceae	1	2.08
Parkia biglobosa (Jacq.) R.Br. ex G. Don.	Fabaceae	1	2.08
Pseudocedrela kotschyi (Schweinf.) Harms.	Meliaceae	1	2.08
Sterculia setigera Del.	Malvaceae	1	2.08
Ziziphus abyssinica Hochst. ex A.Rich.	Rhamnaceae	1	2.08
		314	

Table 2. Diversity of tree/shrub species in the 0.48 ha of natural fallow in the derived savanna ecosystem of Adamawa State.

SPECIES	FAMILY	FREQUENCY	DENSITY (TREES/HA)
Anogeissus leiocarpus (DC.) Guill. et Perr.	Combretaceae	120	250.00
Piliostigma thonningii (Schum.) Milne-Redh.F	Fabaceae	18	37.50
Combretum molle R. Br. ex G. Don	Combretaceae	11	22.92
Vitellaria paradoxa G.F. Gaertn.	Sapotaceae	12	25.00
Detarium microcarpum Guill et Sperr	Caeselpiniaceae	9	18.75
Combretum sp.	Combretaceae	6	12.50
Azadirachta indica A. Juss.	Meliaceae	4	8.33
Combretum glutinosum Perr. ex DC.	Combretaceae	4	8.33
Lannea schimperi (Hochst. ex A. Rich.) Engl.	Anacardiaceae	4	8.33
Pseudocedrela kotschyi (Schweinf.) Harms	Meliaceae	4	8.33
Bombax costatum Pellegr. et Vuill.	Bombacaceae	3	6.25
Acacia polyacantha Willd.	Fabaceae	2	4.17
Combretum gabonense Exell	Combretaceae	2	4.17
Dalbergia sissoo Roxb. ex DC.	Papilionaceae	1	2.08
Bridelia ferruginea Benth.	Euphorbiaceae	1	2.08
Crossopteryx febrifuga (Afzel.ex G.Don)Benth.	Rubiaceae	1	2.08
Ficus sp.	Moraceae	1	2.08
Khaya senegalensis (Desr.) A.Juss.	Meliaceae	1	2.08
Maytenus senegalensis (Lam.) Exell	Celastraceae	1	2.08
Parinari excelsa Sabine	Chrysobalanaceae	1	2.08
Prosopis africana (Guill. et Perr.) Taub.	Mimosaceae	1	2.08
Strychnos innocua Delile	Loganiaceae	1	2.08
Ximenia americana L.	Oleaceae	1	2.08
		211	

Table 3. Diversity of tree/shrub species in the 0.48 ha of grazing land in the derived savanna ecosystem of Adamawa State.

usefulness as a fodder species. The species has also been found very useful for various other purposes such as carving and firewood production, provision tanning and dyeing materials and medicinal application (Sacande & Sanago, 2007). *Philiostigma thonningii* is also a very useful fodder species which produces edible leaves, fruits and seeds. Its versatility as soil improver and provider of shade and many useful products might have accounted for its deliberate retention on the fields by farmers.

Another woody species that was common to the natural fallow and grazing land of the study area is

	TOTAL NO OF TREES/SHRUBS	TREE/SHRUB DENSITY (N/HA)	DIVERSITY INDEX
FOREST	361	752.08	0.85a
GRAZING	211	439.58	0.56c
FALLOW	314	654.17	0.76b

Table 4. Density and diversity indices of trees/shrubs in natural forest, grazing land and natural fallow ecosystems in the derived savanna ecosystem of Adamawa State. Means of diversity index followed by same letters are not significantly different ($P < 0.05$).

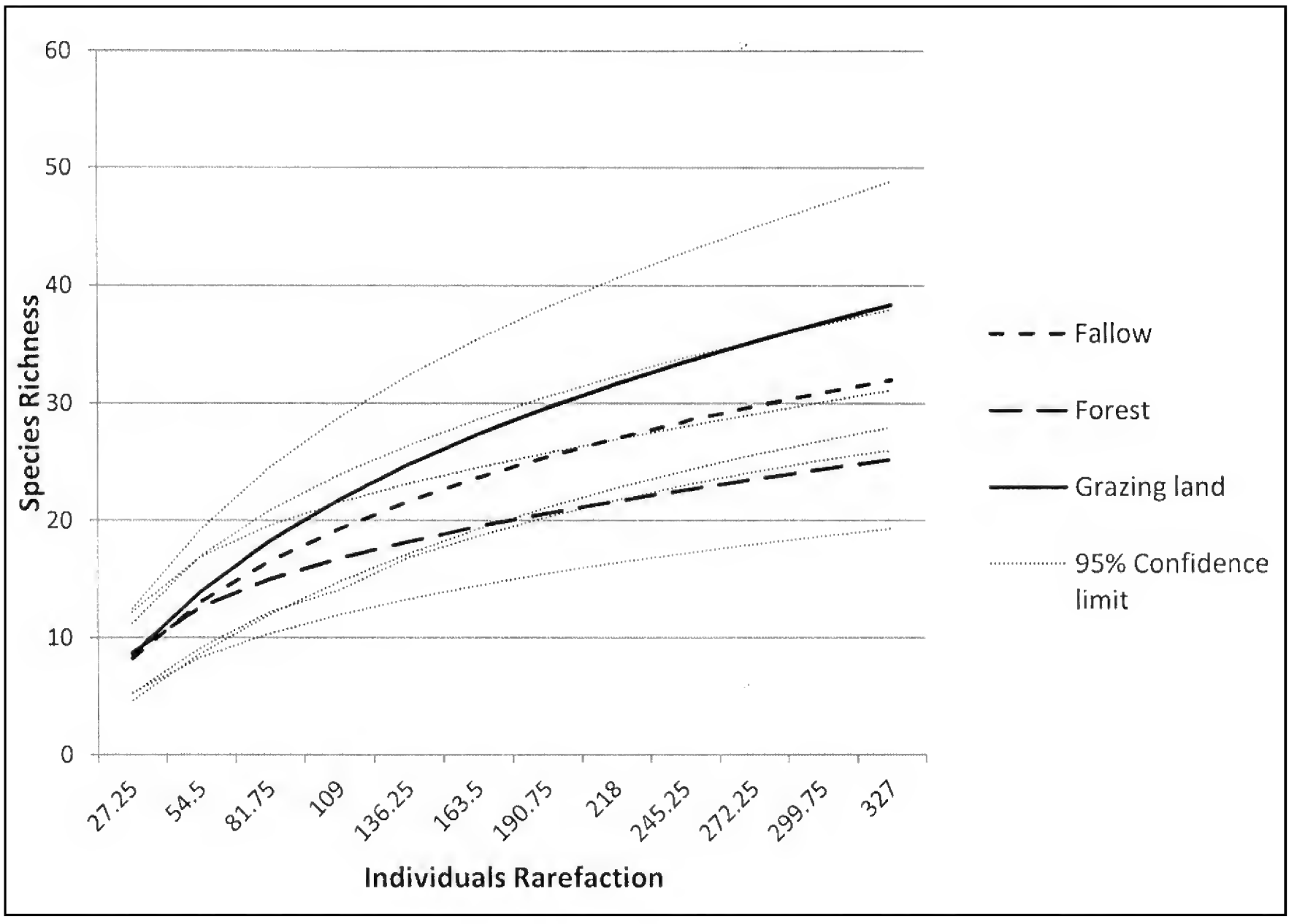

Figure 1. Woody species richness in natural forest, natural fallow and grazing land ecosystems in Gumti area, Nigeria. Individual rarefaction curves and confidence intervals.

Combretum molle. It is an important fodder species whose leaves are browsed by cattle. Its wood is very good for firewood, it produces good quality charcoal and various parts of the plant have been found to be of important medicinal value. The high density of woody species recorded in all sites in this study may be attributed to the use of 5 cm minimum diameter at breast height and the inclusion of shrub species in the enumeration. Expectedly, tree/shrub density was highest in the natural forest while the grazing land had the least value. Although the agroforestry plots contained a large variety of woody species, Shannon index indicated that they show a lower species diversity than the natural forest.

The rarefaction curves in this study indicated that the grazing land had the highest species richness followed by the natural fallow while the least was in the natural forest. This appears to negate the results of Shannon's indices. This may not be unconnected with the fact that there were more individuals in the natural forest relative to the number of different species. Gotelli & Colwell (2001) emphasized the importance of using taxon sampling curves (both individual- and sample-based) to standardize datasets to a common number of individuals for the purpose of comparing species richness.

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REFERENCES

Ashley R., Russel D. & Swallow B., 2006. The policy terrain in protected area landscapes: challenges for agroforestry in integrated landscape conservation. Biodiversity and Conservation, 15: 663-689.

Backes M.M., 2001. The role of indigenous trees for the conservation of biocultural diversity in traditional agroforestry land use systems: the Bungoma case study. Agroforestry Systems, 52: 119-132.

Bhagwat S.A., Willis K.J., Birks H.J.B. & Whittaker R.J., 2008. Agroforestry: a refuge for tropical biodiversity? Trends in Ecology and Evolution, 23: 261-267.

Boffa J.M., 1999. Agroforestry parklands in Sub-saharan Africa. FAO Conservation Guide 34. Food and Agricultural Organisation of the United Nations, Rome, 230 pp.

Chup C.D., 2004. Analysis of agroforestry practices in the Guinea Savanna ecological zone: A case study of the Federal Capital Territory of Nigeria. An Unpublished Ph.D. Thesis, University of Jos, Nigeria, 244 pp.

Ewel J.J., 1999. Natural systems as models for the design of suitable systems of land use. Agroforestry System, 45: 1-21.

Fifanou V. G., Ousmane C., Gauthier B. & Brice S., 2011. Traditional agroforestry systems and biodiversity conservation in Benin (West Africa). Agroforestry Systems, 82: 1-13.

GGNP, 2010. A Wild World of Wonders! Taraba State, Nigeria, 50 pp.

Gotelli N.J & Colwell R.J., 2001. Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. Ecology Letters, 4: 379-391.

Gotelli N.J., 2006. EstimateS statistical estimation of species richness and shared species from samples. http://viceroy.eeb.uconn.edu/EstimateS pages/EstimateS.flx.

Harvey C.A. & Gonzalez-Villalobos J.A., 2007. Agroforestry systems conserve species rich but modified assemblages of tropical birds and bats. Biodiversity Conservation, 15: 555-585.

Kabir M.E. & Webb E.L., 2009. Can homegardens conserve biodiversity in Bangladesh? Biotropica, 40: 95-103.

McNeely J.A. & Scherr S.J., 2003. Ecoagriculture: Strategies to Feed the World and Save Wild Biodiversity. Island Press, Washington D.C., 323 pp.

McNeely J.A. & Scroth G., 2006. Agroforestry and biodiversity conservation - traditional practices, present dynamics and lessons for the future. Biodiversity Conservation, 15: 549-554.

Moguel P. & Toledo V.M., 1999. Biodiversity conservation in traditional coffee systems of Mexico. Conservation Biology, 13:11-21.

Nair P.K.R., Allen S.C. & Bannister M.E., 2005. Agroforestry today: an analysis of the 750 presentations to the 1st World Congress of Agroforestry, 2004. Journal of Forestry, 103: 417-421.

Oboho E.G. & Anyia O.O., 1992. Agroforestry Practices in Semi-Arid Zone of Nigeria. In: Akinsanmi F.A. (Ed.), Proceedings of the 22nd Annual Conference of the Forestry Association of Nigeria, Held in Kano, Kano State, Nigeria, 2nd-7th Nov., 1992, pp. 78-85.

Oke D.O. & Odebiyi K.A., 2007. Traditional cocoa-based agroforestry and forest species conservation in Ondo state, Nigeria. Agriculture Ecosystems and Environment, 122: 305-311.

Perfecto I., Rice R., Greenberg R. & van der Voorst M.E., 1996. Shade coffee: a disappearing refuge for biodiversity. BioScience, 46: 598-608.

Sacande M. & Sanago S., 2007. *Anogeissus leiocarpus* (DC.) Guill. & Perr. Seed Leaflet No. 119, Forest & Landscape Denmark, 2 pp.

Schroth G., Fonseca G.A.B., Harvey C.A., Gascon C., Vasconcelos H.L. & Izac A.-M.N., 2004. Agroforestry and Biodiversity Conservation in Tropical Landscapes. Island Press, Washington, 523 pp.

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New record of the Blue-spotted Cornetfish, *Fistularia commersonii* Rüppell, 1838 (Syngnathiformes Fistularidae), in the South-Western Mediterranean Sea

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ABSTRACT The recent caught of a male specimen of Blue-spotted Cornetfish, *Fistularia commersonii* Rüppell, 1838 (Syngnathiformes Fistularidae), near the coast of Portoscuso, Sardinia, Italy (South-Western Mediterranean Sea, 39°12.17' N / 8°22.44' E) is described. Morphometric and meristic data are reported.

KEY WORDS *Fistularia commersonii*; Lessepsian species; South-Western Mediterranean Sea; Sardinia.

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INTRODUCTION

The Blue-spotted Cornetfish, *Fistularia commersonii* Rüppell, 1838 (Syngnathiformes Fistularidae), is today considered the fastest non indigenous species of the Mediterranean Sea (Azzurro et al., 2013). The Blue-spotted Cornetfish is an Indo-Pacific species with a circum-tropical distribution, being associated with reefs or with shallow sandy bottoms at depths extending down to 132 m (Deidun & Germanà, 2011). *F. commersonii* was described for the first time in the Mediterranean Sea by Golani in 2000 from the coasts of Israel. Following this finding, *F. commersonii* has spread rapidly its geographical distribution all over the Mediterranean, across the oriental (Bilecenoglu et al., 2002; Gokoglu et al., 2002; Corsini et al., 2002; Karachle et al., 2004), central (Azzurro et al., 2004; Fiorentino et al., 2004; Micarelli et al., 2004; Ben-Souissi et al., 2004) and western parts of the basin (Garibaldi & Orsi Relini, 2008; Kara & Oudjane, 2008; Bodilis et al., 2011). In 2007 it was reported off the Southern coasts of Spain (Sanchez-Tocino et al., 2007), which is the farthest a Lessepsian species has ever been recorded from its entry point (CIESM, 2009).

MATERIALS AND METHODS

An adult male specimen of Blue-spotted Cornetfish (*Fistularia commersonii*), was caught in a trammel net at a depth of around 10 m, half a mile from the coast of Portoscuso, Sardinia, Italy (South-Western Mediterranean Sea, 39°12.17' N / 8°22.44' E) in November 2012 (Figs. 1, 2). Such specimen unidentified by the fisherman has been handed by him to the Veterinary Doctors of the Local Health Unit n. 7 of Carbonia who identified it to species. Subsequently, the species was placed in sterile bags (kept in ice boxes at 3°C) during the transport and was immediately frozen at -20°C upon arrival at the laboratory of the Department of Veterinary Medicine in Sassari and was once photographed, weighed and measured. Morphometric and meristic characters were recorded according to the methods described by Strauss & Bond (1990).

RESULTS

The distinctive characters of this species were represented by a total length of 92 cm and by a total weight of 170 grams. All the morphometric and meristic data are reported in Table 1.The body was extremely elongated with tubular shape slightly flattened in dorsal-ventral direction. The skin was naked without bony plaques along the midline of the back. Typically greenish grey to olive in colour, with two rows of blue round spots and a pair of blue stripes along the back. The belly was silvery-white, the fins were transparent at base and with orange crest. The head was very long (approximatively 1/3 of its total length) with star shaped jagged crests on the dorsal part and big and round eyes. It had a narrow long tubular snout with two lateral jagged crests and a small oblique mouth at the end. Dorsal and anal fins both triangular with a similar appearance, a combined total of 14 rays and in opposite positions towards the caudal fin. The caudal fin was forked with the two very elongated and filamented middle rays forming a long whip-like tail filament protruding from its center. Along the sides there were two lines of jagged crests, more visible in the tract from the dorsal fin to the caudal one.

DISCUSSION

A new finding of an adult Blue-spotted Cornetfish (*F. commersonii*) specimen in the Italian waters confirm the widening of its original distribution

VARIABLE	VALUE
Sex	Male
Total weight	170 grams
Total length	92 cm
Head length	30 cm
Height	max 3cm - min 5mm
Dorsal fin length	3.6 cm
Dorsal fin rays number	14
Anal fin length	3 cm
Anal fin rays number	14
Caudal fin length	10 cm

Table 1. Morphometric and meristic data of the *Fistularia commersonii* specimen.

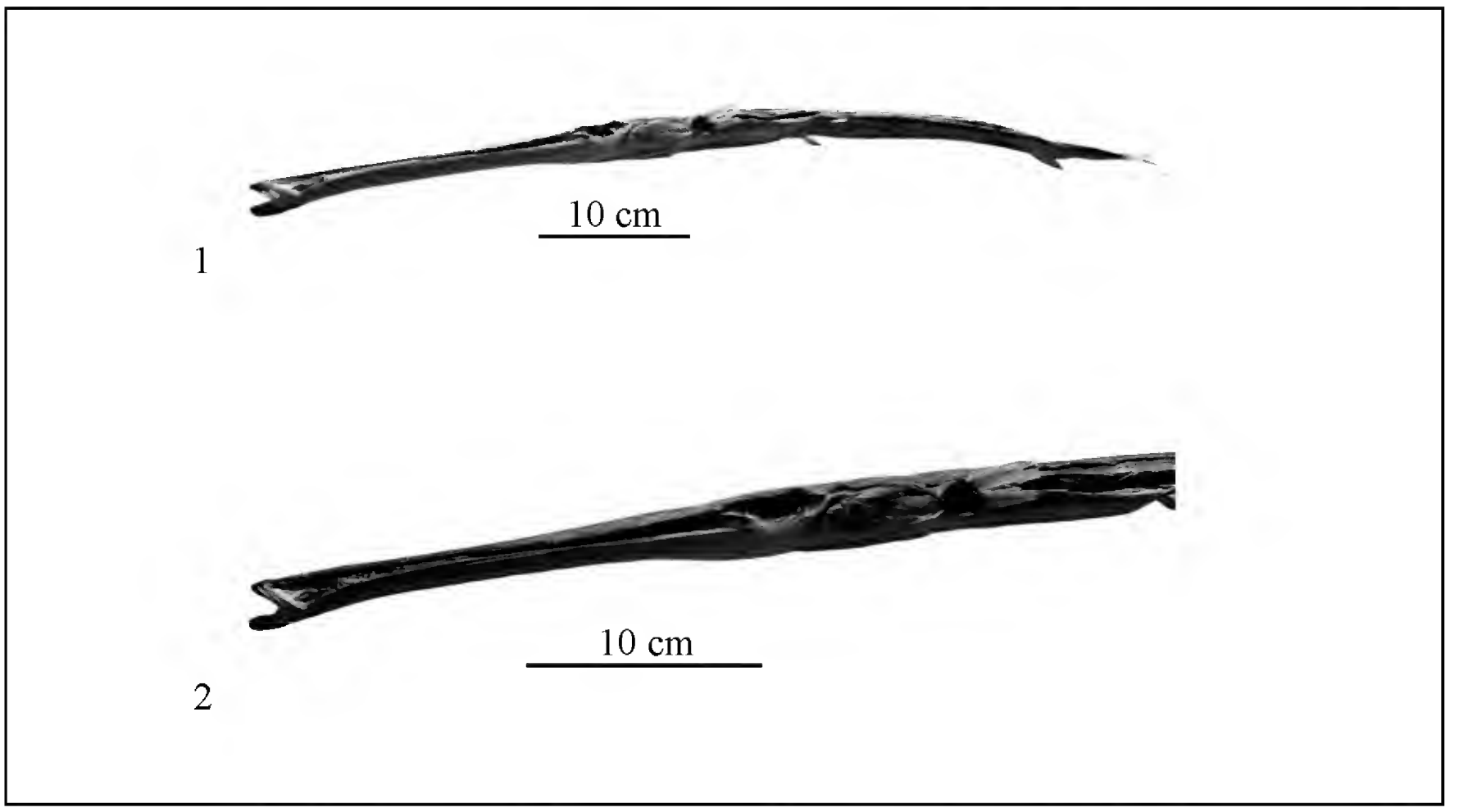

Figure 1. The male specimen of *Fistularia commersonii* recovered near the coasts of Portoscuso Sardinia, Italy.
Figure 2. *Fistularia commersonii*, detail.

area from the Indo-Pacific to the Mediterranean. *F. commersonii* was first recorded in 2002 off the coasts of Sicily (Fiorentino et al., 2004; Azzurro et al., 2004). In the following years established populations along the central Thyrrenian coasts and it was caught from the coasts of Campania (Pipitone et al., 2004) and soon after off the coasts of Latium, Tuscany and Liguria (Micarelli et al., 2006; Ligas et al., 2007; Occhipinti-Ambrogi & Galli, 2008; Psomadakis et al., 2009). The first record of *F. commersonii* in the Adriatic Sea was described by Dulcic et al. in 2008 off the coastal waters of Apulia. This is the most recent record of Blue-spotted Cornetfish in the South-Western coasts of Sardinia (Italy): previous studies (Pais et al., 2007; Sanna et al., 2011) described the record of specimens of Blue-spotted Cornetfish in the coasts of Sardinia since 2005. This new finding confirms that *F. commersonii* is the fastest and furthest spreading alien fish in the Mediterranean Sea (Golani et al., 2007) and that the Sardinian waters represent a model of optimum habitat for the study of the biology and ecology of the *F. commersonii* populations in the Mediterranean Sea.

REFERENCES

Azzurro E., Pizzicori P. & Andaloro F., 2004. First record of *Fistularia commersonii* from the central Mediterranean. Cybium 28: 72-74.

Azzurro E., Soto S., Garofalo G. & Maynou F., 2013. *Fistularia commersonii* in the Mediterranean Sea: invasion history and distribution modeling based on presence-only. Records Biological Invasions, 15: 977-990.

Ben-Souissi J., Zaouali J., Bradai M.N. & Quignard J.P., 2004. Lessepsian migrant fishes off the coasts of Tunisia. First record of *Fistularia commersonii* (Osteichthyes, Fistularidae) and *Parexocoetus mento* (Osteichthyes, Exocoetidae). Vie et Milieu, 54: 247-248.

Bilecenoglu M., Tas¸kavak E. & Kunt K.B., 2002. Range extension of three Lessepsian migrant fish (*Fistularia commersonii*, *Sphyraena flavicauda*, *Lagocephalus suezensis*) in the Mediterranean Sea. Journal of the Marine Biological Association of the United Kingdom, 82: 525-526.

Bodilis P., Arceo H. & Francour P., 2011. Further evidence of the establishment of *Fistularia commersonii* (Osteichtyes: Fistularidae) in the north-western Mediterranean Sea. Marine Biodiversity Records, 4e18, 1-4.

CIESM, 2009. CIESM atlas of exotic species in the Mediterranean Sea: http://www.ciesm.org/online/atlas/index.htm (Accessed 26 June 2013).

Corsini M. & Economids P.S., 2007. Allochthonous and vagrant ichthyofauna in Hellenic marine and estuarine waters. Mediterranean Marine Science, 8: 67-89.

Deidun A. & Germanà A., 2011. On the increasing occurrence of the Bluespotted Cornetfish *Fistularia commersonii* (Rüppell, 1838) in the Central Mediterranean (Osteichthyes, Fistulariidae). Biodiversity Journal, 2: 19-26.

Dulcic J., Scordella G. & Guidetti P., 2008. On the record of the Lessepsian migrant *Fistularia commersonii* (Rüppell, 1835) from the Adriatic Sea. Journal of Applied Ichthyology, 24: 101-102.

Fiorentino F., Giusto G. B., Sinacori G. & Norrito G., 2004. First record of *Fistularia commersonii* (Fistularidae, Pisces) in the Strait of Sicily (Mediterranean). Biologia Marina Mediterranea 11: 583-585.

Garibaldi F. & Orsi-Relini L., 2008. Record of the bluespotted cornetfish *Fistularia commersonii* Rüppell, 1838 in the Ligurian Sea (NW Mediterranean). Aquatic Invasions, 3: 471-474.

Golani D., 2000. First record of the bluespotted cornetfish from the Mediterranean Sea. Journal of Fish Biology, 56: 1545-1547.

Golani D., Azzurro E., Corsini M., Falautano M., Andaloro F. & Bernardi G., 2007. Genetic bottlenecks and successful invasions: the case of a recent Lessepsian migrant. Biology Letters, 3: 541-545.

Gokoglu M., Bodur T. & Gulyavuz H., 2002. The first record of the bluespotted cornetfish (*Fistularia commersonii* Rüppell, 1835) (fam: Fistulariidae) along the Turkish Mediterranean coast. Israel Journal of Zoology, 48: 252-254.

Kara M.H. & Oudjane F., 2008. First observations of the Indo-Pacific bluespotted cornetfish *Fistularia commersonii* (Fistulariidae) from Algerian coasts. Marine Biodiversity Records 2, e83.

Karachle P.K., Triantaphyllidis C. & Stergiou K.I., 2004. Bluespotted cornetfish, *Fistularia commersonii* Rüppell, 1838: a Lessepsian sprinter. Acta Ichthyologica et Piscatoria, 34: 103-108.

Ligas A., Sartor P., Sbrana M., Sirna R. & De Ranieri S., 2007. New findings of *Fistularia commersonii* Rüppell, 1835 and *Sphoeroides pachygaster* (Müller & Troschel, 1848) in the northern Tyrrhenian Sea. Atti Società Toscana di Scienze naturali, Memorie Serie B, 114: 131-133.

Micarelli P., Barlettani M. & Ceccarelli R., 2006. First record of *Fistularia commersonii* (Rüppell, 1838) (Fistulariidae, Pisces) in the North Tyrrhenian Sea. Biologia Marina Mediterranea, 13: 887-889.

Occhipinti-Ambrogi A. & Galil B.S., 2008. The northern most record of the bluespotted cornetfish from the Mediterranean Sea. Mediterranean Marine Science, 9: 125-127.

Pais A., Merella P., Follesa M.C. & Garippa G., 2007. Westward range expansion of the Lessepsian migrant *Fistularia commersonii* (Fistulariidae) in the Mediterranean Sea, with notes on its parasites. Journal of Fish Biology, 70: 269-277.

Pipitone C., D'Anna G., Coppola M., Di Stefano G. & Badalamenti F., 2004. First record of the lessepsian fish *Fistularia commersonii* in the Western Mediterranean. Biologia Marina Mediterranea, 11: 327.

Psomadakis P.N., Scacco U., Consalvo I., Bottaro M., Leone F. & Vacchi M., 2009. New records of the Lessepsian fish *Fistularia commersonii* (Osteichthyes: Fistulariidae) from the central Tyrrhenian Sea: signs of an incoming colonization? Marine Biodiversity Records 2, e49.

Sanna D., Merella P., Lai T., Farjallah S., Francalacci P., Curini-Galletti M., Pais A. & Casu M., 2011. Combined analysis of four mitochondrial regions allowed the detection of several matrilineal lineages of the lessepsian fish *Fistularia commersonii* in the Mediterranean Sea. Journal of the Marine Biological Association of the United Kingdom, 91: 1289-1293.

Sanchez-Tocino L., Hidalgo Puertas F. & Pontes M., 2007. First record of *Fistularia commersonii* Rüppell, 1838 (Osteichtyes: Fistulariidae) in Mediterranean waters of the Iberian Peninsula. Zoologica Baetica, 18: 79-84.

Strauss R. E. & Bond C. E., 1990. Taxonomic methods: morphology. In: Schreck C. B. & Moyle P. B. (Eds.), Methods for Fish Biology. MD: American Fisheries Society, pp. 109-140.